THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XVII.—NO. 416.

VERBUM SAP.!

ALL recollection of the many wild and utterly absurd schemes which were brought forward during the electric light mania of three or four years ago can scarcely yet have faded from the memories of the investing public, and it is to be hoped that past experience will have duly impressed upon the minds of that portion of such public which it has been the custom to term "guileless" the necessity for a degree of caution in dealing with the attempts periodically made to extract gold from their purses. Latterly the field for the exploitation of commercial schemes has been kept moderately clear of the kind of bogus inventions we were accustomed at one time so frequently to run against, the most glaring of recent attempts to foist patent rights meriting the description of idiotic upon an unsuspecting *clientèle* being that of the British Spiral Telephone Wire Syndicate, full particulars relating to which concern may be found in the REVIEW for February 9th, March 15th and 29th, 1884.

Our remarks on this project are now absolutely borne out, the company which was advertised with such a flourish of trumpets having become a thing of the past. But faith still obtains as to the really "guileless" nature of those who have some money and want more, in evidence of which proposition we adduce the registration last week of "Parker's Electric Wire Corporation, Limited."

Somewhat on a par with the invention of spiral wire stands that of Mr. John George Parker, a Plymouth civil engineer, who, on the 4th (this certainly should have been the 1st) of April, 1883, filed a specification for improvements in conductors of electricity. It is a marvel to us that there should exist in these days of enlightenment a civil engineer so ignorant of the elementary teaching of electrical science as to place on record in the Patent Office the assertion that his "invention is based on the principle that the electric current passes along the surface of the wire or other conductor and not through its substance; and further that the insulating material with which it is usual and generally necessary to cover the surface of the conductor operates, by its contact with such surface, to impede and diminish the force of the electric current in its passage along such surface."

Following this remarkable announcement, the "inventor" gives the further information that for the ordinary solid wire conductor he substitutes a special metallic wire or rod conductor so constructed that a section of it shows a central point with a number (varying according to the calibre of the conductor and to all other practical considerations) of metallic spokes or rays radiating therefrom in the form of a conventional star or a wheel. The longitudinal surface of the conductor thus presents a series of parallel and alternate ridges and grooves or channels throughout its length. The insulating cover of the conductor thus formed is so wound round or placed over it as to be in contact only with the apices of these ridges leaving the intervening grooves or channels untouched and unencumbered throughout the whole length of the conductor. Thus, says the inventor, the aggregate metallic surface of the conductor available for the passage of electric currents is composed of the sum of the surfaces of both sides of all these channels or grooves, and is thus very greatly in excess of the surface of an ordinary solid wire of equal calibre or even of the combined internal and external surfaces of a tubular conductor of equal calibre. At each or either end of the conductor, goes on the patentee, there may be inserted into each of the open interstices grooves or channels thereof an ordinary conducting wire, conveying an electric current into or out of the respective grooves or channels of the main conductor, or any number of currants (*sic*) may be concentrated in the receiving extremity of the conductor, so as to pass through its several channels indiscriminately. When the conductor has been properly covered (as above explained) with an impervious insulating cover or envelope of adequate resisting power, a vacuum may be created in the several channels throughout its length, thus further facilitating the passage of the electric current along the internal channels of the conductor. The only claim in the patent is for this "peculiarly-shaped metallic conductor as above described;" yet, by some extraordinary method of suasion unknown to common mortals, this ingenious individual has obtained the support of signatories, and has proceeded to the registration of a company with a capital of £100,000 to purchase and work this delectable patent!

To speak seriously, it is a matter of much concern that persons can be found who are willing to allow their names, without any enquiry into the technical nature of the invention, to be attached as signatories to schemes so palpably absurd; for it is incontrovertible that the public is to a great extent led to an opinion as to the prospects of an undertaking by the degree of respectability attaching to the names of the directorate. Mad, and worse than mad—fairly culpable—is the conduct of those persons who, upon the chance of securing additional fees, assist the introduction of a scheme which may or may not, as far as they are aware, draw money from the unsuspecting public without ever presenting any tangible return.

Consideration of this matter also induces a doubt as to the efficacy of Patent Office supervision. In two of our engineering contemporaries, lately, a considerable amount of correspondence has taken place respecting the ideas which are allowed to form subject matter for letters patent. Certainly, when such specifications as that of Mr. Parker are brought before the Patent Office officials and allowed to pass muster, it is time that some reform be instituted in this department.

B

DYNAMO ARMATURES.

II.

IN our last article the results from toothed armatures were discussed without reference to any reactions which they might have on the magnets. We have now to consider the nature of these reactions. In the case of a smooth armature, the lines of force passing from the magnets into the armature may be represented as in fig. 8, the distribution being fairly uniform over the polar surface with a tendency to accumulation at the edge, which the armature leaves in its rotation. There is, when the armature is revolving, no disturbance of this distribution due to irregularities of armature surface. Although the field may be distorted from various causes, the curvature or "set" which is given to the lines of force is constant while the machine continues to run with the same currents flowing through the

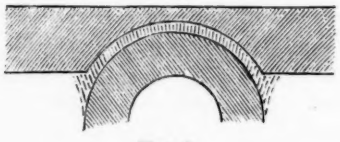


FIG. 8.

field magnets and armature, and since those disturbing influences which would affect the magnetic distribution during the working of the machine are absent, there is manifested with smooth armatures no tendency to heating of the polar surfaces. Foucault currents can be generated only by some change in the magnetic distribution, and in the absence of any cause to effect a change, the heating which results from such currents is entirely absent.

In the case of an armature having projecting teeth, the distribution of the lines of force on the polar surfaces is quite different from that just mentioned. The distribution is more like that shown in

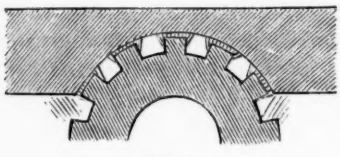


FIG. 9.

fig. 9, where the lines of force are aggregated opposite each projecting tooth, the spaces between the teeth serving as the path for a comparatively small number of them. In fact, we can safely affirm that opposite each projection there originates a dense column of lines of force which projects for some distance into the magnet, eventually blending into adjacent columns. As the armature rotates these columns will move with the projections, and the distribution of magnetism on the poles will be undergoing continual change in consequence. The result with a magnetic distribution, as sketched in fig. 9, can be easily anticipated. The heating of the polar surfaces reveals the existence of Foucault currents caused by the rotation of the armature, and which are due to the surging of lines of force in continual waves over the surface and in the mass of the iron.

The structural modification by which in the Phœnix machine the generation of wasteful currents and consequent heating of the poles have been eliminated is of the simplest possible character. Nothing more is necessary than to allow a somewhat greater air space or clearance between the projecting teeth and the polar surface. If the armature is moved away to a greater distance from the poles, as in fig. 10, the distribution of the lines of force over the polar surface becomes very different. On the surface of each projecting tooth there will be, as formerly, a concentration of lines of force, but over the polar surfaces there will be no longer the same irregular distribution of these lines. The condition of things may be considered as fairly represented in fig. 10, and by a careful adjustment of this space between the armature and poles to the width and depth of the slots the generation of Foucault currents can be completely prevented, or rendered so unimportant that in the longest runs no appreciable heating of the poles is observed.

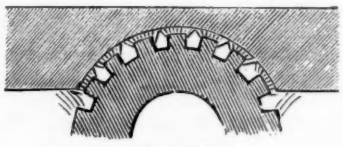


FIG. 10.

The distribution on the polar surfaces is obviously regulated by the width of the projections on the armature and by their frequency; the clearance required must be therefore related in some way to these. From what has been said it will be readily inferred that less clearance is required to neutralise the irregularity of armature surface and to destroy the tendency to heating when for an armature having few projections of considerable angular width we substitute an armature with a greater number of projections occupying each a proportionally smaller angular space. The inference is completely verified by experiment, and an examination of the machines in which Pacinotti armatures are employed shows that when a clearance between the projections and the pole pieces proportional to the angular width of the projections is not given, the heating of the poles is very much greater with the armatures having few projections than with those having the surface cut up into a greater number. From this point of view the most effective armature is one having a large number of very narrow slots, for by making the slots sufficiently narrow the clearance between the projections and the polar surfaces can be diminished until it is only sufficient to ensure safety from a mechanical standpoint. In practice, however, the slotting of the armature is not pushed to its utmost limit. The armature which had formerly 18 slots, described and illustrated in our last article, has now 36 and sometimes 48 slots, the clearance between the projections and the poles being in the former case ·25 inch, and in the latter case ·18 inch. In the later Phœnix machines one-half of the total exterior surface of the armature is formed by the projecting teeth, the width of the projections being kept as nearly as possible equal to the width of the slots. The total area of the exterior surface of the projections is never less than that of the cross section of the magnets, and the clearance between the armature and the magnets is equal to the width of the slots × ·35. In machines having this amount of clearance no heating of the poles is experienced; by the simple expedient of increasing the distance between the field-magnets and the armature the detrimental reactions are destroyed, the distribution of the lines of force on the polar surfaces remaining then unaffected by the rotation of the projecting teeth.

In small dynamos having weak fields the heating of the polar surfaces is not in most cases developed to an extent likely to cause attention to be drawn to the subject, but the heating increases with the strength of the field, and in large dynamos with strong fields it is important that every possible precaution be taken to prevent the generation of wasteful currents. When employing the magnets illustrated in fig. 3, slotting the pole-pieces was at one time tried to prevent the heating, but the device was found worthless. Judging roughly, this makes no appreciable difference to the generation of Foucault currents, the limit to lamination being in practice soon reached unless the field were built up like the armature, which would mean enormous cost, and which, moreover, is, as has been shown, quite unnecessary.

The means employed to eliminate the reactions of the armature on the magnets necessarily modify to a cer-

tain extent the results obtained from the experiments described in our first article. Increasing the air space between the armature and magnets increases the resistance of the magnetic circuit, and to obtain now the same results as were formerly obtained we have to put, if the electrical resistances are to remain the same, a greater quantity of wire on the magnets. What we have to determine is whether the toothed armature possesses an advantage over the smooth armature when the reactions are destroyed, seeing that to accomplish this we have had to increase the magnetic resistance and thus sacrifice part of the advantage shown to have been gained. In the armatures which were tested the results shown by the curves to have been obtained from the toothed armature are too high, for the projections are brought too close to the poles; also the results given by the smooth armature are too low, since the iron core might have been of larger outside diameter and consequently nearer to the pole pieces. But after allowing for both these corrections it can be shown that there is an advantage in employing armatures with projecting teeth. It must be remembered that, apart from mechanical advantages, the only electrical advantage to be gained from the projections takes the form of a diminished resistance of the air space for a given area of the polar surface.

Consider the armature of a 200-light machine, which is $13\frac{3}{8}$ inches diameter and which has 36 slots. The slots are $\frac{5}{8}$ inch wide by $\frac{3}{4}$ inch deep, the distance between the projecting teeth and the polar surface being $\frac{1}{4}$ of an inch all round. To get the same area of conductor on a smooth core we should require the wire laid on the surface of the iron to a depth of $\frac{3}{8}$ inch, which, allowing $\frac{1}{16}$ inch for the space occupied by the insulating material on the core and by the binding bands, and $\frac{1}{8}$ inch for the clearance between the armature and the magnets, gives a total of $\frac{9}{16}$ inch for the distance between the armature core and the magnets. As a matter of fact we should have for the smooth armature, in order to obtain the same resistance of air space as with the toothed armature described, a clearance between the armature core and magnets of only $\frac{3}{8}$ of an inch. If the clearance of the smooth armature were $\frac{3}{8}$ inch the resistance offered by the air space would be the same as that offered in the case of the armature with projections, but since the clearance required in the former case is $\frac{9}{16}$ inch it follows that by slotting the armature we have reduced the resistance of the air space to two-thirds of its former value. Cutting out the slots reduces the circumferential surface, but to make up for this the diminished surface is brought nearer to the magnets, and by reason of the clearance given the sides of the teeth have become valuable relatively to the circumference. Many of the lines of force now find a path to the interior of the armature core by the sides of the teeth.

In conclusion, then, it appears that after due allowance has been made for the prevention of wasteful currents we have in armatures of the Pacinotti type, if constructed in accordance with the data here given, the resistance of the air space reduced by about 30 per cent. In the Phœnix machine the clearance considered simply as clearance is rather excessive, but the reason for this now appears, and the double advantage of being able to secure at the same time an excessive clearance and a more efficient armature will be recognised. Finally, when we remark, in addition to these advantages, the impossibility of the wires moving on the core, we conclude that mechanically and electrically there is a distinct gain in employing Pacinotti's armature.

W. B. ESSON.

The Electrical Transmission of Power.—We shall hope to be able in our next issue to devote some of our space to the analysis of the figures given by M. Marcel Deprez as the results of the Creil experiments. The question is one which should be thoroughly sifted, and all fanciful data eliminated.

ELECTRIC LOCOMOTION.

By A. RECKENZAUN.

II.

THERE is not the slightest necessity for us to endeavour to disprove the assertion, made twenty-eight years ago, that "electric power depends on zinc;" everyone knows that steam engines, gas engines, or water-wheels are now the principle agents in the production of powerful electric currents; the mechanical energy of these prime movers is readily converted into electrical energy by simply moving copper wires or other conductors between the poles of powerful magnets. The space between and around the magnet poles is termed the magnetic field, and it is assumed that the magnetism travels through iron or steel in lines, which are called magnetic lines of force. The stronger the magnet is, the denser are these lines of force; and there is a practical limit to the number of lines of force which a piece of iron of a given sectional area can carry at an economical rate of exciting power. If we move a straight piece of copper wire (the ends of which we join to a galvanometer) at a given velocity within the magnetic field, cutting the lines of force at right angles, we find that a current of electricity is set up in the copper wire; two such wires placed side by side, but with their ends connected, when moved in the same magnetic field at the same velocity will produce the same current with double the electromotive force; thus we may fill up the circumference of a drum or cylinder with wires parallel to one another and to the axis of rotation, and thereby obtain an electromotive force proportional to the number of wires cutting the magnetic lines. It will take twice the power to move two similar wires within this uniform field that it does to move one, and twenty times the power to move twenty wires with a given velocity. By rotating these (wires which may be held by a cylinder) twice as fast in the same magnetic field, we get double the electromotive force, and again exert double the power in causing rotation of the cylinder, or, as it is commonly called, the armature of a dynamo-electric machine. These are the most elementary principles involved in the mechanical production of electric energy. There were at the International Inventions Exhibition a number of dynamo-electric machines which were so well constructed that it would appear almost impossible to suggest further improvements; these machines did not only work without requiring any more attention than, for instance, a substantially made water pump, whilst they converted over 80 per cent. of the mechanical power which drove the spindles into electrical energy, but it appeared, from the inappreciable amount of wear, that they cannot easily be worn out. It will be interesting to know the actual depreciation in dynamo machines as recently manufactured by the most eminent makers, such as Siemens, Crompton, Mather and Platt, Kapp, the Brush Company, Paterson and Cooper, and a few others; we are inclined to estimate this item at 7 per cent. on the selling price. These successful firms have each a particular type or design of dynamo, and they all know that with a certain quantity of iron and copper they are able to obtain a definite effect at a given efficiency; we may, therefore, safely say that dynamo-electric energy, as at present understood, depends on mechanical power causing conductors to move in a magnetic field. We have nothing to do with the construction of dynamo machines; our aim is to utilise the electric energy delivered at the terminals, and utilise it to the best advantage. We propose to transmit the current from the dynamo (generator) to another dynamo (motor), and by means of the latter convert electric energy into mechanical power. All continuous current dynamos are reversible; that is to say, by sending a current through the field-magnet coils and the armature coils, the magnetic poles set up in the iron cores attract and repel each other, as the case may be, and thereby produce motion or continuous rotation. Now this very act of rotation, the moving of the armature

coils in a magnetic field, causes a reaction, a counter current, or, as generally termed, a counter electromotive force is set up in the armature, which appears to impede the flow of electricity from the generator to the motor. This counter electromotive force is greatest when the armature rotates fastest, that is, when the motor is allowed to do little work, but then the current consumed is extremely small. If we exert a sufficient force upon the armature spindle so as to prevent rotation entirely, then the current circulating through the motor circuit will be large, because no counter electromotive force is generated, and the whole of the current is converted into heat instead of work. Thus, according to Ohm's law, the current flowing when the armature is prevented from revolving will be

$$C = \frac{E}{R}$$

where E represents the electromotive force at the terminals of the machine, and R the resistance of the machine. As soon as we allow the armature to revolve a counter E.M.F., e, is generated, when the current will be reduced to

$$c = \frac{E - e}{R}$$

or, knowing C and c by direct measurement we can calculate

$$e = \frac{C - c}{C} E;$$

the electrical work put into the machine is $W = E\,c$, the *useful* electrical work which the motor takes up is $w = e\,c$,
therefore the electrical efficiency must be

$$f = \frac{w}{W} = \frac{e}{E} = \frac{C - c}{C}.$$

By Joule's law we know that heat waste caused by the current circulating through a known resistance R is

$$J = c^2 R.$$

This heat waste being the only loss which we are at present taking into account, we have

$$W = w + J$$

therefore by substituting the above values we get

$$W = w + c^2 R$$

and

$$w = W - c^2 R,$$

and if we substitute $\frac{E - e}{R}$ for c we obtain

$$w = \frac{(E - e)\left\{E - (E - e)\right\}}{R}$$

$$= e\,\frac{E - e}{R}$$

These simple expressions, it must be remembered, refer to the motor only, and no account is taken of such losses as friction, Foucault currents, and churning air, which factors depend upon the mechanical construction, and which will be considered separately.

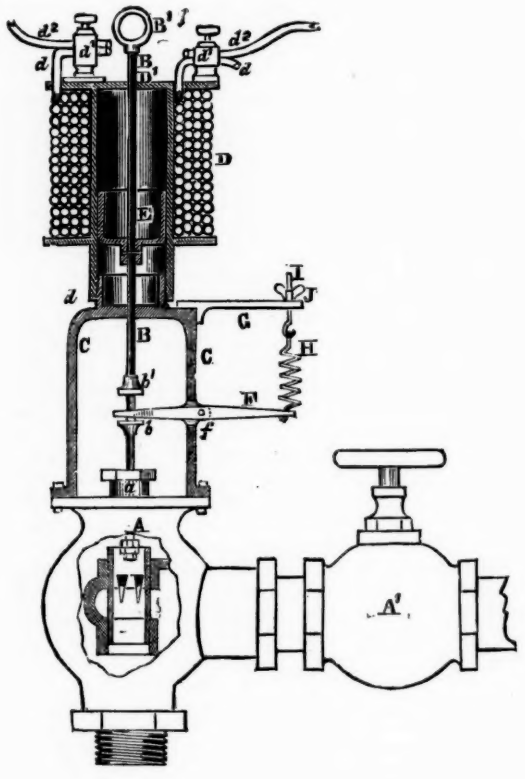
We propose to set at once to work and test a motor which is ready at hand; we have an unlimited supply of current from a dynamo or any other convenient source. We shall run this motor at various speeds, using various E.M.Fs. and currents, and thereby obtain all sorts of powers and efficiencies. Now in order to obtain reliable results, we must have reliable instruments wherewith the energy absorbed can be readily measured, viz., ampèremeters and voltmeters; the mechanical power got out of the motor we measure by an absorption dynamometer and a speed counter. Since we have the choice of several kinds of dynamometers or brakes, we may devote a little time to the study of the construction and use of a few of these indispensable apparatus; for the value of the results depends not only upon the care taken in making observations, but largely upon the condition our instruments may be in at the time.

AN ELECTRIC GOVERNOR FOR STEAM ENGINES.

The *American Engineer* illustrates and describes a new electric governor for steam engines recently patented by Mr. A. L. Ide, the well-known engine builder, of Stringfield, Ill.

The accompanying cut shows the governor valve located in the steam supply pipe of an engine, combined with the electric mechanism and adjusting devices by which the position of the valve is controlled in the operation of the electric current.

A is the governor valve, and A′ is the stop-valve of the steam-supply pipe. B is the stem of the governor valve. C is the arch. D is a hollow helical electromagnet surmounting the arch, and E is an armature attached to the stem, B, and adapted in form and position to enter the spool of the magnet, D.



The engine with which the governor is to be used, is supposed to drive an electric generator or dynamo of any form, which dynamo may be used exclusively for the purpose of operating the governor, or it may also be connected to supply any desired number of electric lights, or to do any other form of work for which such apparatus is required or adapted. The method of connecting the helix, D, of the governor in the current from the generator is sufficiently indicated.

The valve shown has the special feature of being able to close by an extreme movement in either direction. It consists of an open-ended cylinder provided with openings through its sides in its middle portion, and seated within two cylindric seats, embracing its opposite ends, the seats being cast in the same piece, but separated by a passage by which the steam is admitted around the central portion of the movable valve between the seats, so as to enter the ports, and find escape at opposite ends of the valve. The valve and its seats are enclosed within a globe shell in the usual manner of this general class of valves. The valve can be operated

to partially shut off the steam from the engine by a movement in either direction, and will be perfectly closed when the central ports are brought wholly within either the upper or the lower cylindric seats. The cylinder is, of course, constructed of such length that when the central ports are brought into either seat so as to close them, the other end at the same time protrudes into the opposite seat and cuts off the supply of steam.

In the application of this valve to the purposes of an electric governor, as herein contemplated, it is designed that the ports of the valve shall work in connection with the upper cylindric valve seat, the ports being closed more or less as the valve is thrown upward by the action of the electric current through the magnet; but it is also contemplated that after the engine is shut down, by closing the stop-valve, A′, in the usual way, the valve shall be forced downward so that its ports are closed within the lower seat. In case the electric current is broken, or in case the driving belt of the engine is broken, the valve will be closed by being thrown downward so that its ports are carried with the lower seat.

In the construction of the electrical arrangement the helix, D, is applied to a hollow spool with its axis coincident with that of the valve stem, B, being mounted fixedly upon the arch, C. The insulated wires, *d*, *d*, terminate in binding posts, *d*′, fixed to the spool, as shown, one or both of said posts being properly insulated from the spool, and both being adapted to receive the wires, d^2, d^2, leading to and from the dynamo, and thereby bringing the helix, D, into the electric circuit of said dynamo. The valve stem, B, is provided with the armature, E, affixed thereto in proper position with reference to the helix to be raised by the latter when the force of the electric current is augmented therein. Said stem is also provided with the fixed collars or shoulders, *b*, *b*′, between which projects the branched end of the lever, F, pivoted in the arch, C, at *f*. The outer end of the said lever is connected with the fixed arm, G, by the contractile spring, H, made adjustable as to its tension by the screw-threaded hook, I, and thumb nut, J.

By depressing the outer end of the lever, F, the stem, B, may be raised to bring the valve, A, into working position, as shown—that is to say, with the ports in the steam space between the seats. Whenever the speed of the engine becomes too great, the corresponding excessive force of the electric current, operating through the magnet D, will raise the valve and bring its ports partly within the upper seat, and thereby proportionately cut off the steam supply and lower the speed of the engine. Said stem is also shown prolonged through the upper end plate, D′, of the spool (which serves as a guide), and provided at its free extremity with a ring, B′, by which also the valve may be raised to working position.

The lower shoulder, *b*, is exclusively used in the operation of the apparatus, being the only one upon which the lever bears by reason of the action of the spring in opposition to the attractive force exerted by the electro-magnet on the armature. The upper shoulder is used when in starting the machine it is desired to lift the valve by bearing down with the hand on the outer end of the lever. By placing the shoulders at a distance apart such as shown, the upper shoulder cannot normally rest on the lever so as to hold the valve up, it being observed that a valve of this class closes by reason of its weight automatically when the current is shut off or broken, and thereby prevents the engine from running away. The ring, when present at the top end of the valve stem, may, however, be taken hold of and used as a means for conveniently lifting the valve stem, in place of depressing the outer end of the lever.

In the use of the particular form of valve shown, or of other forms having similar action, should the current be broken the valve falls by its weight, or by its weight re-enforced by the spring, H, and closes off the steam supply by carrying the ports of the cylindric valve into the lower seat.

Not only may the required uniformity of engine speed be obtained under varying work, as in other forms of governor, but in the use of the engine for the purpose of generating electricity for illumination the speed of the engine will be lessened or accelerated automatically when a number of lights are shut off or connected into the circuit. By means of the adjusting device applied to the spring, H, operating through the lever, F, as described, a greater or less intensity in the lights may also be obtained, various forms of lamps requiring different intensities of current may be interchangeably used, and the number of lamps in the circuit may be varied from time to time, as may be desired, the adjustable spring being readily varied in its tension so as to control the valve in opposition to currents of different power.

After the above description of the devices employed a detailed description of the operation is unnecessary. It is obvious that in the normal working of the machine the action of the magnet is to draw the valve cylinder upward, so that its ports will be regulated as to their area, and so as to control the amount of steam admitted to the engine in accordance with the force exerted by the magnet upon the armature, E, the spring, H, operating through the lever, F, to depress the valve and open the ports whenever the force of the current is diminished. While the spring, H, however, thus operates in conjunction with the magnetic current, it is plain that when said current ceases, as may happen from a variety of causes, or when a driving belt breaks or is thrown off its pulleys between the engine and the dynamo, the effect of said spring will be to instantly throw the cylindric valve to its extreme lower position, carrying its ports within the lower seat so as to shut off steam. In other words, the spring, H, operates to open the ports when the electric current is in action through the magnet, D; but in the absence of such current it serves to give the valve a throw of such extent as to close said ports and shut off steam. By using other means to close the valve in case the current is broken or a belt is thrown off, or by omitting all devices for this purpose, the adjustable spring, H, may be employed with other forms of valve than that here shown, with the same effect as to the variation of force in the magnet, D, under conditions above mentioned.

It is manifest that a solid core magnet may also be employed, if preferred, with only mechanical modifications of the construction shown.

It is further obvious that the governor described may be applied to control an engine through the medium of a variable cut off by connecting the armature with the rod or other part operating the cut off mechanism.

ON SOME PRACTICAL ELECTRICAL FORMULÆ.

(For Use in Constructing Circuits, Electro-magnet Coils and Dynamos.)

By F. V. ANDERSEN

PART I.—(*Continued from page* 390.)

On a Constant $\kappa = \text{Resistance} \times \frac{\text{section}}{\text{length}}$.

In winding smaller coils, such as all sorts of telegraph electro-magnet coils, galvanometers, &c., the space is not quite so economically used; the extra insulation whenever a joint appears amounts to a good deal. I have by a number of observations found $K = \cdot 79 \times 10^{-6}$ to $\cdot 8 \times 10^{-6}$ to be the nearest. In fact, $\cdot 79 \times 10^{-6}$ gives quite satisfactory results in dealing with this sort of coils.

From my own experience I can recommend the above formula for actual practice. It is true that winders have an admirable sense for guessing the right sizes; but a formula is always to be preferred to a rule of thumb. In winding dynamo shunts a for-

mula is simply necessary to avoid expensive practical experiments. The formula allows moreover for variation in thickness of the insulating coat.

For wires of too small a size to be kept strictly in layers (dia. under 10 mils.), I find $K = \cdot62 \times 10^{-6}$ about.

For German silver resistance coils wound with wires over 10 mils. dia., in layers, I find

$$K\,g.\,s. = 11\cdot5 \times 10^{-6}$$

Now $K\,g.\,s.$ should bear the same relation to K as specific resistance of German silver bears to that of copper

$$\frac{11\cdot5}{\cdot79} = 14\cdot56.$$

which is, in fact, very near equal to the average proportion of the two resistances.

EXAMPLE *a*.—Construct a shunt for a dynamo to give with an electrical efficiency, η, of 85 per cent. 60 ampères in external circuit and 80 volts at terminals, adjustment being allowed in the speed to obtain exactly the 80 volts.

c = ampères in external circuit = 60;
c_s = „ in shunt;
C = „ in armature = $c + c_s$;
E = volts produced in armature conductor;
e = „ at terminals of dynamo = 80;
L = total length of armature conductor in feet = 785;
s = section of „ „ in square ins. = ·010936;
ra = ohms of armature between brushes.

The dynamo is supposed to be two-polar with a gramme commutator.

We have for the shunt machine

$$\eta = \frac{c}{C} \times \frac{e}{E} = \frac{c}{C} \times \frac{e}{e + \varepsilon}$$

ε, the fall of potential in armature, $= C \times ra$, and

$$ra = \frac{\kappa}{4} \times \frac{L}{s}$$

($\frac{\kappa}{4}$ because two halves of armature conductor are in parallel arc from brush to brush).

$$\therefore \eta = \frac{c}{C} \times \frac{e}{e + C\,ra} = \frac{c\,e}{C\,e + C^2\,ra}$$

$$\therefore C^2\,ra + C\,e - \frac{c\,e}{\eta} = 0$$

$$\therefore C^2 + C\,\frac{e}{ra} - \frac{c\,e}{\eta\,ra} = 0$$

$$\therefore C = \frac{-e + \sqrt{\frac{4\,ra\,c\,e}{\eta} + e^2}}{2\,ra}$$

since $ra = \frac{\kappa}{4}\frac{L}{s}$ this means

$$C = \frac{2\,s}{\kappa\,L}\left(-e + \sqrt{\frac{\kappa\,L}{s} \times \frac{c\,e}{\eta} + e^2}\right)$$

The working temperature of the dynamo is supposed to be 45° C., which gives $\kappa = 9\cdot28 \times 10^{-6}$. The formula then gives

$$C = \frac{2 \times \cdot010936}{9\cdot28 \times 10^{-6} \times 785} \times \left(-80 + \sqrt{\frac{9\cdot28 \times 10^{-6} \times 785}{\cdot010936} \times \frac{60 \times 80}{\cdot85} + 80^2}\right)$$

$$= 62\cdot48 \text{ ampères.}$$

$\therefore c_s = 62\cdot48 - 60 = 2\cdot48$ ampères in shunt.

Resistance of shunt:

$$R = \frac{80}{2\cdot48} = 32\cdot26 \text{ at working temperature or } 45° \text{ C.}$$

This shunt is wound into two coils, each to have 16·13 ohms at 45° C.

A shunt coil has length = 11·5 inches; depth = 1· inches; mean length of a turn = 25·3 inches.

From which

$$v = 11\cdot5 \times 25\cdot3 = 291 \text{ cubic inches.}$$

The insulation is double cotton, which on wires of the size here in question has a radial thickness of ·008 inches = δ.

$$\kappa \text{ by } 45° \text{ C.} = 9\cdot28 \times 10^{-6}$$

$$\therefore K = \frac{9\cdot28 \times 10^{-6}}{3\,\pi} = \cdot985 \times 10^{-6}$$

By formula VIII.:

$$d = -\delta + \sqrt{\sqrt{\frac{K\,v}{R}} + \delta^2}$$

Therefore

$$d = -\cdot008 + \sqrt{\sqrt{\frac{\cdot985 \times 10^{-6} \times 291}{16\cdot13}} + \cdot008^2}$$

$$\therefore d = \cdot0574.$$

If this size of wire is not available, the shunt may be constructed of the nearest finer and the nearest thicker gauges which are ·056 and ·064 ins. diameter.

By formula VII.:

$$R = K\,\frac{v}{D^2\,d^2}$$

this formula will for the present case have to be modified thus

$$R = K\left(\frac{v - v_f}{D_0^2\,d_0^2} + \frac{v_f}{D_f^2\,d_f^2}\right)$$

where v_f is the space to be filled with the finer wire of diameter D_f and d_f respectively, $v - v_f$ is the space to filled with the thicker wire of diameter D_0 and d_0 respectively, we get:

$$\frac{R}{K} = \frac{(v - v_f)\,D_f^2\,d_f^2 + v_f\,D_0^2\,d_0^2}{D_0^2\,d_0^2\,D_f^2\,d_f^2}$$

from which

$$v_f = \frac{\frac{R}{K}D_0^2\,d_0^2 - v}{\frac{D_0^2\,d_0^2}{D_f^2\,d_f^2} - 1} \qquad \text{IX.}$$

Now, when

rf = resistance of finer wire
rt = resistance of thicker wire

then

$$rf = \frac{K\,v_f}{D_f^2\,d_f^2}$$

and inserting above value for v_f

$$rf = R\,\frac{D_0^2\,d_0^2 - K\,v}{D_0^2\,d_0^2 - D_f^2\,d_f^2} \qquad \text{X.}$$

in casu

$$rf = 16\cdot13\,\frac{\cdot08^2 \times \cdot064^2 - \cdot985 \times 10^{-6} \times 291}{\cdot08^2 \times \cdot064^2 - \cdot072^2 \times \cdot056^2} =$$

13·68 ohms (45° C.)

$rt = R - rf = 16\cdot13 - 13\cdot68 = 2\cdot45$ ohms (45° C.), or at normal temperature (15·5° C.):

$rf = 12\cdot28$ ohms
$rt = 2\cdot20$ ohms

EXAMPLE *b*: Find the space required for a German silver resistance = coil of 10 ohms, which has to carry $\frac{1}{2}$ ampère:

Smaller size German silver wires carry for a short time without appreciable heating 400 ampères per square inch.

Section required therefore = $\frac{\cdot5}{400} = \cdot00125$;

Diameter = ·040 covered with double silk to ·056,

from formula VII.:—

$$v = \frac{R\,D^2\,d^2}{K}$$

$$\therefore v = \frac{10 \times \cdot056^2 \times \cdot040^2}{11\cdot5 \times 10^{-6}} = 4\cdot4 \text{ cubic inches.}$$

F.—*The diameter of the wire for a shunt* which, excited by a given number of volts, has a magnetising power of a given number of ampère turns. This forms part of the common problem :—Construct a dynamo to supply C ampéres at E volts, running at N revolutions per minute.

By an experiment, the number of ampère-turns required to produce E volts at N revolutions and with C ampères in external circuit is determined.

Let this number of ampère turns be = T;
mean length of a turn in feet = l;
number of turns in a shunt coil = n;
total length of wire in do., do., in feet = L;
section of shunt wire, in square inches = s;
ampères in shunt = C_s;
resistance in ohms of each shunt coil = R;
volts for each shunt coil = e;
($e = \frac{E}{m}$, m being the number of shunt coils in series).

We then have—

known, T, l and e;

unknown, n, L, s, C_s, R, D and d.

Now

$$T = n \times C_s \text{ and } n = \frac{L}{l} \text{ and } C_s = \frac{e}{R};$$

further,

$$R = \frac{\kappa L}{s},$$

from which

$$T = n \times C_s = \frac{L}{l} \times \frac{e\,s}{\kappa L} = \frac{e\,s}{\kappa\, l},$$

but

$$s = d^2 \frac{\pi}{4},$$

so

$$T = \frac{e\,d^2\,\pi}{4\,\kappa\,l} \qquad \text{XI.}$$

$$\therefore d = 2\sqrt{\frac{\kappa\, l\, T}{e\,\pi}}, \qquad \text{XII.}$$

d being found also, D will be known ($d + 2\delta$), and then

$$L = \frac{v}{12\,D^2} \quad \text{(formula VI.)}$$

$$n = \frac{L}{l};$$

$$R = \frac{\kappa L}{s};$$

$$C_s = \frac{e}{R}.$$

EXAMPLE.—It was found, by way of an experiment, that the dynamo treated under E above would, by 600 revolutions per minute, give 80 volts and 60 ampères, when each of its two shunt coils was excited by 6,880 ampère turns. Construct the required shunt.

Given T = 6880;
l = 2·108 (25·3 inches);
e = 40·
v = 291·

from formula XII.;

$$d = 2\sqrt{\frac{\kappa\, l\, T}{e\,\pi}}$$

$$\therefore d = 2\sqrt{\frac{9\cdot28 \times 10^{-6} \times 2\cdot108 \times 6880}{40 \times 3\cdot1416}} =$$

$$2\sqrt{\frac{\cdot928 \times \cdot2108 \times \cdot688}{125\cdot664}}$$

$$\therefore d = \cdot0655;$$

$$\therefore D = \cdot0655 + \cdot0165 = \cdot082;$$

$$\therefore L = \frac{291}{12 \times \cdot082^2} = 3606 \text{ feet;}$$

$$\therefore n = \frac{3606}{2\cdot108} = 1710.$$

$$\therefore R = \frac{9\cdot28 \times 10^{-6} \times 3606}{\cdot0655^2\,\frac{\pi}{4}} = 9\cdot93 \text{ ohms (45° C.)}$$

$$\therefore C_s = \frac{40}{9\cdot93} = 4\cdot03 \text{ ampères.}$$

Weight of copper for each shunt coil = L × s × 3·84 lbs. = 3606 × ·00337 × 3·84 = 46·7 lbs.

REMARK.—From formula XI. $\left(T = \frac{e\,d^2\,\pi}{4\,\kappa\,l}\right)$ it is seen that T, the exciting power of the shunt, is independent of both C_s and n. This means that when the right wire is used (diameter = d), the number of turns actually laid on may be modified to suit mechanically (to give a full number of layers, for instance), as this involves no practical alteration in the power of the shunt. The consequence of reducing to a small extent the number of turns is a proportionately stronger current through the remaining coils and lower efficiency of the machine. The output of the machine will remain the same as with the full number of turns and resistance calculated, so long as the reduction is not great enough to cause a remarkable increase in the working temperature of the shunt; for in this case the corresponding increase of κ will make the value of T go down.

ON THE THEORY OF THE ELECTRO-MAGNETIC TELEPHONE-TRANSMITTER.

By M. E. MERCADIER.

THE first point to be studied in this theory is the part played by the iron or steel diaphragm of the telephone.

1. From the *elastic* point of view as regards the nature of the movements which it effects. 2. From the *magnetic* point of view, in the transformation of mechanical energy into magnetic energy resulting from its movements.

I. If there are produced in the air in front of the diaphragm vibratory movements, simple or complex, like those resulting from articulate speech, either the fundamental and harmonic sounds of the diaphragm are not produced or they play merely a secondary part.

In fact: 1. The diaphragms are never set in vibration as it is supposed, if we wish to determine the series of the harmonics and of the nodal lines; for they are not left to themselves when they have been set in motion; no free play is given to the action of the elastic forces: in a word, the vibrations effected are constantly forced.

2. If a disc is absolutely set in a groove, when its borders are fixed, theory indicates that the first harmonics of the free disc ought to rise only a little. Let us take discs of steel of 0·10 metre in diameter, and only 0·002 metre in thickness, the fundamental sound of which, in the free state, is about ut_5, and which is further raised by framing in. We do not see how this fundamental and the harmonics can be brought into play when there is produced before the disc a continuous series of sounds or of accords of a pitch below ut_5, or when a man, the pitch of whose articulate speech is always in the gamut of index 3, speaks into a diaphragm of this kind. Nevertheless, these sounds and this speech are perfectly reproduced (with a feeble intensity, indeed, in an ordinary telephone) with their pitch and their timbre. They produce, therefore, in the transmitting diaphragm, movements other than those of the fundamental sound and of its particular harmonics.

3. It is true that in practice the edges of the telephonic diaphragm are in no manner fixed, but merely enclosed between pieces of wood or of metal, the mass of which is comparable to their own: they are, therefore, as regards elasticity in conditions not well determined. Still, a diaphragm of ordinary diameter (from 0·05 to 0·10 metre) and very thin (from 0·25 to 0·5 millimetres in thickness), enclosed in this manner at its edge, is capable of vibrating if a continuous series of sounds is produced near it, by means, for instance, of a series of organ-pipes. But the series of sounds which it distinctly strengthens by manifesting complex nodal lines is visibly *discontinuous;* how, therefore, can its existence suffice to explain the production of a continuous scale of sounds—sounds, isolated or superimposed, which is the essential property of the telephone?

4. The interposition between the diaphragm and the source of the vibratory movements of a plate of any substance whatever, in no-wise affects its telephonic qualities, nor, consequently, the nature of the movements, which would be very surprising if it were these which correspond to the particular sounds of the diaphragm. This fact is already known. I have verified it with mica, glass, zinc, copper, cork, cotton, wood, paper, feathers, soft wax, sand and water, taking certain of these substances even in thicknesses of 0·15 to 0·20 metre.

5. We may put a diaphragm manifestly out of condition to produce its particular scale of harmonic sounds, by loading it with small masses irregularly distributed over its surface, by cutting it in form of a wheel, or of piercing it with holes, so as to deprive it of the half of its mass. None of these modifications destroys its telephonic properties.

6. We may go still further and employ diaphragms of a rigidity and an elasticity almost nil, without affecting the essential telephonic properties, that is the reproduction of a continuous series of sounds of accords, &c. Such is the case with a diaphragm of sheet-iron. It is very difficult then to imagine a fundamental sound and its harmonics.

The conclusion of all this seems to me to be that the mechanism in virtue of which telephonic diaphragms execute their movements is at least analogous to, if not identical with that by which solid bodies of any form—a wall, for instance—transmit to one of their surfaces all the vibratory movements, simple or complex, successive or simultaneous, and varying in period in a continuous or discontinuous manner, which are produced in the air in contact with the other surface. In a word, we have here a phenomenon of *resonance*. In diaphragms of a sufficient thickness, this kind of movement would exist alone; in slender diaphragms the movements corresponding to their particular sounds may be superposed on the former; a superposition more troublesome than useful, for if there results in these cases a strengthening of the effects produced, it is at the expense of the timbre, as the harmonics of the diaphragm can only by the greatest chance coincide with those of the sounds which bring into play the fundamental sound of the diaphragm, as experience distinctly proves.

II. Let us now pass to the magnetic part of the telephonic diaphragm. This part may be clearly defined by the following facts.

1. The presence of the magnetic field does not at all modify the foregoing conclusions.

2. By diminishing more and more the rigidity and elasticity of the diaphragm, I succeeded in suppressing it completely. It is sufficient to substitute for it in any telephone, a few grains of iron-filings, thrown upon the pole of the magnet, covered with a piece of paper or pasteboard, in order to reproduce, though with a very feeble intensity, all sounds and articulate speech, with its characteristic tone.

3. To augment the intensity of the effect produced, it is sufficient to substitute for the iron diaphragm, a slender disc of any substance, slightly flexible, whether metallic or not, *e.g.*, pasteboard, and to spread over it, across the opening of the ordinary cover of the instrument 0·1 or 0·2 grm. of iron filings, which marks out in the space the lines of force.

We obtain thus an iron-filings telephone. By suitably increasing the intensity of the magnetic field, I have been able to obtain telephones of this kind, producing in an ordinary recipient, effects as intense as the ordinary transmitters with rigid discs, and like them, reversible. For a field of given intensity, there is a weight of filings which produces a maximum effect.

We see thus that the advantage of an iron diaphragm over filings is reduced to presenting in one and the same volume, a much more considerable number of magnetic molecules to the action of the field and to external actions. It increases the intensity of telephonic effects; but to produce them with all their variety, their delicacy and their perfection, it is by no means indispensable: it is sufficient to materialise in some manner the lines of force with iron-filings, and to act mechanically upon them, and consequently upon the field itself.—*Comptes Rendus.*

MEASUREMENT OF THE STRENGTH OF TELEPHONE CURRENTS.*

By CHAS. R. CROSS and JAMES PAGE.

So far as is known to the authors of the present paper no measurements have ever been made of the strength of such telephone currents as are actually used in the transmission of speech. The few figures that have been given are estimates rather than measurements. Some very interesting results are given by Dr. C. J. Blake (*Jour. Soc. Tel. Engineers*, 1878) regarding the logographic values of the different vowels as determined by the throw of the needle of a mirror galvanometer used in connection with a magneto transmitter. This logographic effect, however, should be carefully distinguished from that of the alternating currents utilised in the continuous transmission of sound, as, even with apparatus suitable for the measurement of such currents, it is liable to mask the phenomena to be studied unless care be taken to avoid such disturbing effects.

The lack of figures in so interesting and important a subject as the one under consideration arises from the fact that an electro-dynamometer of some form must be used for the necessary measurements, and an exceedingly sensitive instrument is essential in order to obtain sufficient deflection to give results of any value.

A form of electrical balance, similar to that figured by Maxwell ("Electricity and Magnetism," 2nd Ed., Vol. II., p. 342), was at first constructed, but this failed to give satisfactory results. Subsequently success was obtained by using a unifilar electro-dynamometer, made by Hartmann, of the form described in "Wiedemann's Annalen," Vol. XV., 1882, p. 550. The instrument was modified by removing the heavy movable coil furnished by the maker, which was of altogether too low resistance for our purpose, and replacing it by a lighter and closely wound coil of No. 36 (B. and S.) copper wire with a suspending wire of the same gauge and 40 centimetres in length. The resistance of the instrument was 206 ohms, that of the suspended coil being 166 ohms. In some of the experiments the metallic vane, which in the instrument described by Kohlrausch dips into a vessel of dilute sulphuric acid, was removed, and a needle point dipping into mercury substituted, the connection with the telephone being made through this. But the greater freedom from disturbance when the vane was used made it preferable. The rapid alternation of current prevented any difficulty from polarisation, as was shown by the fact that with a source of sound of constant intensity the same results were obtained whether dilute sulphuric acid or mercury was employed. A reading telescope and scale

* Read at a meeting of the American Academy of Arts and Sciences, October 14th, 1885.

graduated to millimetres served to determine the deflections of the dynamometer coil, the telescope being at a distance of 1·5 metres from the mirror.

The dynamometer was usually placed in the secondary circuit of a small induction coil, the resistance of the secondary circuit of which was about 800 ohms. The microphone transmitters were placed in the primary circuit, with two Grenet cells arranged in parallel circuit. When the magneto transmitter was used it was placed directly in circuit with the electro-dynamometer.

The dynamometer was so placed that when no current was flowing the axis of its suspended coil was at right angles to the magnetic meridian. No special pains were taken to secure this accurately, as the action of the deviating couple due to the earth's magnetism was found to be quite negligible in comparison with variations caused by unavoidable differences in the intensity of the sounds acting upon the transmitter. Deflections of the suspended coil were read by the use of a mirror, telescope and scale, as the ordinary method of bringing the scale-reading back to zero by moving the torsion head of the instrument could not be used, since it was impossible with the voice to sustain a note for a sufficient length of time. The deflections were therefore read by the observer, and the strength of the current subsequently determined from these by the following method :—A Daniell cell was placed in circuit with the dynamometer, using a mercury contact to avoid the polarisation which would ensue with dilute sulphuric acid, and by means of a rheostat interposed in the circuit the resistance was varied until deflections were obtained corresponding with those given by the telephone currents. The electromotive force of the cell divided by the total resistance in the circuit gave the current corresponding to any given deflection. A galvanometer was also inserted in the circuit, but as there was some uncertainty about its constant and law of deflection, which we were prevented from determining by want of time, the method already stated was relied upon, merely using the figures given by the galvanometer as a check upon the results. The current strength as given in this paper is therefore the strength of the steady current which gives the same dynamometer reading as the alternating currents of the telephone. No correction for the self-induction of the dynamometer was attempted, as the range of variation in the readings shows that at the present stage of our research no real increase in accuracy would be secured by doing this.

The absence of any means of obtaining a definite and constant intensity of the voice renders it very difficult to obtain uniformity in results. Care was, however, taken not to continue the experiment very long at any one time, as the voice of the singer or speaker became wearied, and was less under control.

In telephonic experiments care must be taken, as already intimated, to avoid the logographic disturbance that arises from the strong air pressure developed on beginning the utterance of different sounds, as the magnitude of the temporary deviation produced by this often far exceeds the permanent deflection which is given by the continuous telephone current. This can be done by raising the voice very gradually, but a better method, which we have employed, is to interpose a key, which keeps the circuit open until the sound is fully developed. Then on closing the circuit the deflection quickly becomes steady, and the disturbance in question is avoided.

Measurements were made with the Hunnings, Fitch, Blake, Edison, and Bell magneto transmitters. The Hunning transmitter uses carbon in a granulated form, and the Fitch employs two hard carbon discs as electrodes. The structure of the other transmitters is too well known to require any description.

The vowels, *a*, *o*, *u*, *i* (German sounds), were spoken or sung into the transmitter successively, all at the same pitch, viz., the b of 480 vibrations, and with the same intensity as nearly as this could be realised. The deflections obtained are given below in full in order to furnish some idea of the degree of uniformity obtained. Several separate series are given for each transmitter. In some cases the loudness of the voice varied somewhat in passing from one series to the next.

The readings are given in centimetres and tenths.

Some experiments were also made upon a Dolbear electrostatic receiver in circuit with a Hunnings transmitter and high resistance induction coil. The currents produced when speech was readily transmitted and reproduced by the Dolbear receiver were too slight to be measured by the dynamometer, although amply sufficient to reproduce speech in a magneto receiver interposed in the circuit.

HUNNINGS TRANSMITTER.

	a	*o*	*u*	*i*
(1)	8·0	17·5	7·0	1·7
	7·5	12·2	7·0	1·2
	7·3	15·2	8·0	1·8
	9·2	12·3	8·4	1·8
	7·4	12·5	7·9	1·9
(2)	11·5	15·5	9·8	4·0
	15·0	30·0	10·0	3·7
	15·0	20·5	11·0	3·5
	14·0	17·0	10·0	3·5
	12·5	18·5	11·0	3·0
(3)	10·0	12·5	6·5	1·5
	10·0	11·5	7·5	2·0
	13·0	15·0	8·0	2·5
	11·5	12·5	5·0	2·5
	10·1	12·4	7·0	2·2
(4)	12·5	13·0	8·0	2·0
	10·5	15·0	7·2	3·0
	12·5	15·0	9·0	2·5
	12·5	16·0	8·9	3·5
	12·0	16·0	8·7	3·5

FITCH TRANSMITTER.

	a	*o*	*u*	*i*
(1)	7·5	9·5	7·5	4·0
	5·5	9·0	7·0	4·0
	6·5	9·0	4·2	1·7
	5·0	6·5	7·0	4·5
	5·5	6·7	6·4	4·2
(2)	6·2	8·0	5·7	1·8
	6·5	7·4	5·5	0·8
	5·0	7·4	5·4	3·8
	5·4	7·7	5·4	2·7
	6·5	7·0	6·0	2·0
(3)	6·0	7·4	6·1	2·1
	6·2	9·0	6·0	3·0
	6·4	8·2	5·5	2·7
	5·4	8·0	5·5	2·4
	5·7	8·0	6·2	3·2

BLAKE TRANSMITTER.

	a	*o*	*u*	*i*
(1)	0·5	0·3	0·2	0·0
	0·4	0·7	1·3	0·1
	0·4	0·8	0·4	0·0
	0·3	0·7	0·4	0·0
	0·4	0·7	0·3	0·0
(2)	0·3	0·7	0·3	...
	0·6	0·7	0·4	...
	0·6	1·2	0·3	...
	0·4	1·0	0·5	...
	0·5	0·8	0·5	...
(3)	0·5	0·8	0·4	...
	0·6	0·8	0·3	...
	0·5	0·9	0·3	...
	0·5	0·6	0·6	...
	0·7	0·8	0·7	...

EDISON TRANSMITTER.

	a	*o*	*u*	*i*
(1)	0·3	0·4	0·8	0·2
	0·3	0·5	1·1	0·1
	0·3	0·7	0·8	0·1
	0·2	0·7	0·7	0·1
	0·3	0·5	0·7	0·3
(2)	0·3	0·5	0·7	0·1
	0·2	0·7	0·8	0·1
	0·2	0·7	0·8	0·2
	0·2	0·6	0·4	0·1
	0·4	0·7	0·3	0·2
(3)	0·4	0·9	0·5	0·1
	0·2	0·7	0·5	0·1
	0·2	0·8	1·1	0·2
	0·3	0·7	1·2	0·2
	0·4	0·8	0·8	0·3

MAGNETO TRANSMITTER.

	a	*o*	*u*	*i*
(1)	0·4	1·2	0·8	0·1
	0·3	1·3	2·3	0·3
	0·6	4·0	3·6	0·3
	0·4	2·9	5·4	0·5
	0·3	2·0	3·4	0·2
(2)	0·7	1·0	2·1	0·2
	0·4	1·2	2·0	0·3
	0·6	1·3	2·0	0·7
	0·6	2·2	3·2	0·7
	0·8	2·7	2·7	0·5
(3)	0·6	3·1	2·2	0·4
	0·6	2·7	2·3	0·3
	0·5	2·2	1·9	0·3
	0·6	2·3	2·4	0·5
	0·7	2·5	2·2	0·2

At first sight some of the results given in the preceding tables are quite unexpected. Thus in some cases the magneto transmitter gives as great or even a greater current than the Blake carbon transmitter, although, as used in actual practice, the latter is far louder. This probably comes from the fact that with the magneto transmitter the lips were habitually placed close to the mouth-piece of the instrument, so that even if the same actual strength of voice is used the effect on the diaphragm of the magneto is greater than on the diaphragm of the Blake transmitter. It was impossible to use the same loudness of voice with the lips close to the mouth-piece of the latter transmitter, as the scratching sound which always appears with a microphone too strongly excited became very marked. We therefore, while keeping the voice at the same intensity, removed the mouth farther from the transmitter until the scratching ceased. In fact, the difference in the size and shape of the mouth-piece of the different instruments, and the position of the mouth in speaking, whether pressed against the mouth-piece or at a little distance from it, always affect both the absolute and relative strength of the vibrations of the diaphragm with different vowels, and hence, of the resulting currents. A further interesting illustration of this will be seen by comparing the results with the Hunnings and Edison transmitters.

In another series of experiments the sound of a C_4 stopped organ pipe, giving 512 vibrations per second, was substituted for the voice. Very great constancy in its intensity was secured by blowing it with a blast and using a very large bottle as a pressure regulator. Three tubes were inserted through the cork of the bottle. Through one of these the air from the blast entered the bottle; through a second it passed to the organ pipe, while the third tube was drawn to a small aperture at its extremity, which allowed a greater or less quantity of air to pass out, according as the pressure from the blast tended to increase or diminish. Observations were made at intervals for ten minutes. Only slight oscillations of the coil occurred during this time. The following are the mean readings with the different transmitters:—Hunnings, 7·9; Fitch, 3·4; Blake, 0·7; Edison, 0·2; Magneto, 0·05. The strength of the current in ampères in the different experiments was as follows:

VOWEL SOUNDS.

HUNNINGS TRANSMITTER (FROM SERIES 3).

Vowel.	Mean Deflection.	Current.
a ...	10·9 ...	0·000737
o ...	12·8 ...	0·000787
u ...	6·8 ...	0·000503
i ...	2·1 ...	0·000213

FITCH TRANSMITTER (FROM SERIES 3).

a ...	5·9 ...	0·000450
o ...	8·1 ...	0·000548
u ...	5·8 ...	0·000442
i ...	2·7 ...	0·000264

BLAKE TRANSMITTER (FROM SERIES 3).

a ...	0·6 ...	0·000123
o ...	0 8 ...	0·000144
u ...	0·5 ...	0·000114
i ...	... ...	...

EDISON TRANSMITTER (FROM SERIES 1).

a ...	0·3 ...	0·000088
o ...	0·6 ...	0·000123
u ...	0·8 ...	0·000144
i ...	0·2 ...	0·000072

MAGNETO TRANSMITTER (FROM SERIES 2).

a ...	0·6 ...	0·000123
o ...	2·6 ...	0·000260
u ...	2·2 ...	0·000238
i ...	0·4 ...	0·000103

SOUND OF C_4 ORGAN PIPE.

Transmitter.	Current.
Hunnings	0·000550
Fitch	0·000361
Blake	0·000132
Edison	0·000072
Magneto	0·000114

In the case of some of the very small deflections observed the current was calculated on the assumption that the deflection varied as the square of the strength of the current.

A few preliminary experiments were made, using a method by which we hope to obtain further results. A Thomson quadrant electrometer was used with the telephone on the same plan as that originally suggested by Joubert for its use with dynamo machines giving alternating currents. The needle and one pair of the quadrants were connected with one terminal of the telephone, and the other pair of quadrants with the remaining terminal. There was not sufficient time at our disposal to obtain any series of measurements by this method, but results were reached which give encouragement as to its availability. It is possible that this method may prove especially useful in the study of electro-static telephones.

The results given in the preceding pages are to be regarded only as preliminary to a more extended series of measurements. But while they are yet necessarily somewhat meagre, they seem at least to show first, that an electro-dynamometer of a simple construction is sufficient, not merely to detect, but also to measure telephone currents; and, second, that the strength of these currents, especially when good carbon microphone transmitters are used, is far in excess of what has hitherto been supposed.

The Telpherage System.—A contemporary adversely criticises the system of telpherage inaugurated recently at Glynde. That contemporary, however, is somewhat inconsistent and contradictory in its remarks. For instance, it says:—"We should not like to say that there is nothing meritorious in the telpherage system;" and later on in the same article asserts that: "We must at present refuse to see any other merit in it but novelty, if that be any."

ATOMICAL MAGNETISM AND ELECTRICITY.

MANY theories of magnetism have been published, which may be more or less analogous to the processes that exist in nature; but most of these theories assume the existence of mediums, or of properties, of which we can form no sensate conception. Moreover, although magnetism and electricity are intimately connected, but few theories have been suggested that are common to both. I have heard, however, of a theory by Mr. A. J. S. Adams, who has endeavoured to illustrate atomical magnetism without using any imaginary mediums.

Mr. A. J. S. Adams takes as his magnetic element the atom; he assumes this atom to be an oblate ellipsoid, and that it has a rapid rotation round its shortest diameter. This rotation of the atom determines its polarity, since the atom, when viewed at opposite ends of its axis, appears to revolve in reverse directions.

The preceding illustration may be extended to electrical phenomena, by using the rotation of the atom, to represent the electricity of the one electricity theorists.

Suppose, then, that the atoms of matter have a rotary motion inherent in them, that the amount of this rotation in nature is a constant quantity, and that it tends to diffuse itself equally amongst all the atoms; then an electric current may be assumed to consist of the transfer of this rotary motion from atom to atom.

Each transfer of motion from a more rapidly rotating atom to a less rapidly rotating one would be accompanied by a loss of energy in the form of electricity, and an equivalent production of energy in the form of heat; and since the amount of energy embodied in each atom is proportional to the square of its velocity of rotation, the amount of heat produced would be proportional to twice the square of the motion (electricity) transferred. Conversely, of course, when motion is transferred from a less rapidly rotating atom to a more rapidly rotating one, an equivalent amount of energy is consumed in performing the work.

The two electricities theory fails to illustrate in an intelligible manner the production of a current by the motion of a conductor in the magnetic field. Electricity has also electro-static properties which are difficult to reconcile with the theory that it is a vibratory motion. But if it is supposed that there is but one electricity, and that that electricity is analogous to a rotary motion, then both electro-static and magnetic induction may be illustrated in a simple and plausible manner.

Experiments have proved that while an electric discharge is taking place the atoms are arranged in a definite manner with respect to the alignment of the discharge. And the difference in the inductive capacity of different substances demonstrates that static induction consists of an arrangement of the atoms along the paths that the discharge tends to take. It seems to me evident that the arrangement of the atoms during static induction and electric discharge is identical; and that the circular magnetism of the electric current is due to the passage of the current; that is, to the transfer of motion from atom to atom.

Thus the arrangement of the atoms during static induction and electric discharge may be compared to a tendency of the atoms to place the plane of their equators parallel to the alignment of the discharge; so that each atom would tend to place its poles in any position at right angles to the alignment of the discharge. This arrangement of the poles of the atoms alone constitutes static induction; but this arrangement of the poles of the atoms, together with the passage of the current, produces circular magnetism.

Circular magnetism is produced, therefore, by a deflection of the equatorial plane of the atoms towards the alignment of the current. Polar magnetism is produced by a further deflection of the atoms with respect to a line at right angles to the alignment of the discharge; since in polar magnetism similar poles of each element are deflected towards the same direction. Thus polar magnetism tends to deflect the equatorial plane of each atom parallel to a given plane, and to make the north and south sides of the plane point in similar directions; while circular magnetism tends only to deflect any line in the equatorial plane of each atom towards the alignment of the electric discharge.

A magnetically-induced current may be accounted for by supposing that the motion of a conductor along the lines of force of a magnetic field tends to stop the rotation of the atom, and to drive it out of the conductor, as it were. But since the magnetic field arranges the atoms of the conductor in a definite manner, the rotary motion would be driven out of the conductor in a particular direction; and this direction of the "current" would depend upon the direction in which the conductor was moved.

Thus, when a conductor is moved along the lines of force an electric pressure (+ potential) is produced at one end of the conductor, and an electric vacuum (— potential) at the other end. The rotary motion "electricity" would be, of course, driven out at the pressure end of the conductor; but as the pressure exterior to the magnetic field would drive electricity "rotation" into the vacuum end of the conductor, this electricity would have to be driven through the conductor and out at the pressure end. In this manner an electric current would be kept circulating through the conductor.

W. MOON.

GAS DETECTOR FOR MINES.

THE *Scientific American* describes a device designed to automatically send an alarm when explosive gas, such as coal gas, natural gas, or fire damp, accumulates at the place where it is located. An oil lamp or gas burner is secured to the bottom of a wire netting cylinder, provided at its upper end with diametrically opposite pins, which project into eyes formed near the lower ends of pivoted angular levers. The upper ends of the levers carry electric contact points connected with wires leading to a battery, and are pulled toward each other by a spring; the lower ends of the levers

FIG. 2.

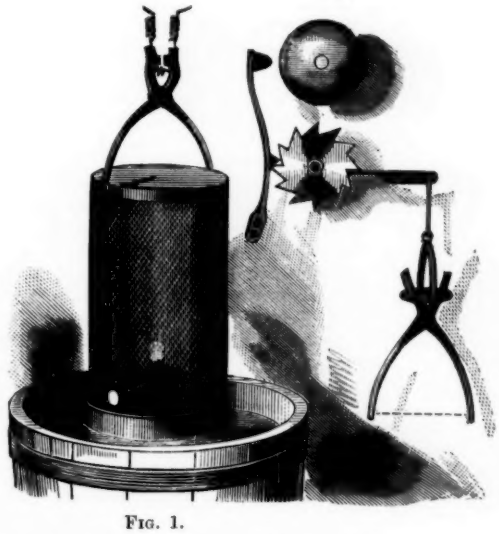


FIG. 1.

are united by a cord or highly fusible wire. The cylinder is held above a vessel containing water. The gas, fire damp, &c., passes through the wire netting and is ignited, and burns the cord or melts the wire, thereby permitting the spring to pull the lower ends of the levers from each other, when the lamp drops into the water, and is extinguished. At the same time the contact points are brought together, the current is closed, and an electric bell in the circuit is sounded. The remaining gas does not explode, as only the gas in the cylinder is burned. In the modification shown in fig. 2 the upper ends of the levers are held in a ring

suspended by a stirrup hung on one end of a pivoted lever, the other end of which engages with a ratchet wheel provided with a drum on which a weighted cord is wound. A spring hammer, operated by the ratchet wheel, strikes a gong. The lower ends of the lever are kept from spreading by a wire or cord. When the cord is burned, the upper ends of the lever swing toward each other and drop through the ring. The lever, being relieved of its weight, releases the wheel, which operates the hammer. This invention has been patented by Mr. James A. Lyon, of Clarksville, Tenn.

THE CORNELL TANGENT GALVANOMETER.

AN American Exchange, in a recent issue, describes the tangent galvanometer constructed at Cornell University, from the designs of Mr. Anthony, the Professor of Physics, to meet the want of a standard instrument for the measurement of heavy currents, and for the direct calibration of the commercial instruments in use for measuring the currents employed in electric lighting, &c. For the measurement of heavy currents there are four circles, two 2 metres in diameter, and two 1·6 metres, mounted, according to Helmholtz's plan, at distances apart equal to their radii. The conductors forming these circles are copper rods, three-fourths of an inch in diameter. The needle is suspended by a silk fibre in a mass of copper, which serves as an effectual damper, and makes it possible to take readings very rapidly. By a peculiar arrangement of mirrors and telescope the deflections are read directly in angular measure on a circle 50 inches in diameter, to within three-tenths of a minute of arc. The copper conductors are mounted on a brass framework accurately turned and adjusted, and the dimensions are all known within one five-thousandth. For the measurement of small currents there are two circles, about 1·5 metres diameter, each having two conductors, and comprising altogether 72 turns of No. 12 copper wire.

The indications of such an instrument of course depend upon the value of the horizontal intensity of the earth's magnetism, and without some means of determining this quantity in the place where the instrument stands, and at the time when a measurement is being made, no great accuracy is attainable. For making this determination, a coil a metre in diameter, consisting of 100 turns of No. 18 wire, is suspended, so that its centre coincides with the centre of the instrument, by means of a single phosphor-bronze wire, which is itself attached to a torsion-head reading to 10 seconds of arc. By the aid of this coil, observations may be taken at any moment for the determination of H by the method proposed by Sir William Thomson. The instrument is mounted in a copper building, from the construction of which all iron has been rigidly excluded. Several conducting wires connect the building with the dynamo and other rooms of the physical laboratory, 550 feet distant, and switches in the building serve to send the currents through the several coils of the galvanometer singly, in series, or in multiple arc, direct or reversed. By this means currents from 1 milliampère to 250 ampères can be accurately measured.

REVIEWS.

High School Science Series. Lectures on Heat, Sound, and Light. By R. WORMELL, D.Sc., M.A. London: Thomas Murby, 3, Ludgate Circus Buildngs, E.C.

The author of these lectures justifies the addition of the work to the numerous existing text-books of the kind on the educational method of the work, and not upon its subject matter. Mr. Wormell (Head Master of the City of London Middle Class Schools) has aimed at giving the information a gradually progressive character, and we think he has succeeded in his aim. The general style of the matter is decidedly taking, and very practical. The author, we regret to notice, however, has committed the great mistake, which we have always protested against, of giving a number of examination questions without answers to them.

Chemical Students' Manual for the Lecture Room and Laboratory. By H. L. BUCKERIDGE, F.C.S. London: Thomas Murby, 3, Ludgate Circus Buildings, E.C.

There is much in this book which is commendable, and comparatively little which calls for criticism. The work is divided into three parts, entitled, respectively, "Chemical Notabilia," "Qualitative Analyses of Simple Salts," and "Chemistry of the Non-Metallic Elements." The use of paragraph headings in deep black type is an advantage which will be appreciated.

NOTES.

Covent Garden Theatre Lighting.—We understand that the Jablochkoff system at Covent Garden Theatre has been, on the whole, so satisfactory, that M. Riviére, who has recently undertaken a new series of Promenade Concerts, will continue to light the theatre as heretofore. Weldon, M. Riviére!

The City Lighting.—On Tuesday evening the Brush lamps around Ludgate Circus were observed to go out, and one, we believe, was completely destroyed by burning up. It is but rarely that one has to chronicle such an occurrence, and it would be interesting to know the cause of the failure.

The Lord Mayor's Show.—The erection in Aldersgate Street representing the old Alders Gate "as it was 100 years ago," was illuminated by means of four Pilsen arc lamps, supplied by Messrs. Paterson and Cooper, and run from a Phœnix dynamo at that firm's works in Little Britain. We suppose the learned gentlemen who superintended the decorative arrangements in Aldersgate Street know best, but we were certainly under the impression that the invention of the Pilsen arc lamp was of more recent date.

Mr. Sugg on the Electric Light.—At the annual meeting of William Sugg and Company, Limited, Mr. Sugg, referring to the Inventions Exhibition, said:—"One of their most attractive exhibits was the new 'Cromartie' light, which, he might tell them, had attracted the attention of a very eminent engineer at the annual dinner of the Institution of Civil Engineers, who thought at first it was an *exceedingly good electric light.* They could now confidently recommend the light as a practical thing to work. There were 12 or 14 of these lights fixed about the Exhibition at South Kensington; these lights had been at work night and day since they were fixed, and were considered most satisfactory; in fact, the police have said they would not like to trust themselves to the electric light alone. The authorities at the Exhibition, however, were so persistent upon electric lighting, that they did not seem disposed to give gas a chance. Next year there were to be two exhibitions—the 'Colonial,' at South Kensington, and a very large American exhibition at Fulham. The probability was that the authorities would hire or buy some of the new lights for these exhibitions, but there was no doubt, notwithstanding that we could do the lighting very much cheaper with gas, that the electric light would be used as much as possible. While on the subject of exhibitions, the shareholders would perhaps have noticed that the company had lighted the new subway leading from South Kensington Station to the Inventions Exhibition. It was

originally intended to employ the electric light, but considering the probability of its going out, it was determined to use gas, and at the last moment the company had to labour night and day to get the work done." Who would suppose, after reading this last sentence, that the facts are that the electric light has been almost exclusively used for the whole length of the subway from the day of opening to the very last night, and that the eleven Sugg lamps therein have been merely supplemental and a provision against any possible accident to the wires, just as in a house supplied with gas it is no uncommon thing to have a few candles ready for lighting when the water gets into the pipes, or any other hitch occurs with the service? In fact, the candle is not uncommonly found disastrously handy in case of a gas escape having to be searched out.

Electric Lighting Tenders.—Tenders are invited for lighting by electricity seven shops and premises in course of erection in Fore Street, Redruth, Cornwall. Mr. J. Hicks is architect.

Complaints of the Electric Lighting Machinery at Paddington.—At Marylebone Police Court last Tuesday, Colonel Barnett, of Westbourne Terrace, Mr. Jonas, of Orsett Terrace, and Mr. Munro Scott, of Gloucester Crescent, Paddington, applied to Mr. De Rutzen, as a deputation of the residents of Gloucester Crescent, to ask for assistance in a matter which they said was of very great importance to them. It was explained that the Great Western Railway Company, for the purpose of lighting their premises and the line between Paddington Station and Westbourne Park by electricity, had recently erected in the immediate rear of Gloucester Crescent machinery of so powerful a character that the houses in the neighbourhood were made almost uninhabitable. The machinery had latterly been at work night and day, Sunday included. The tremendous vibration and noise, added to the fumes of smoke, steam, and the dirt caused by the machinery, produced such a nuisance as to be almost unbearable. The noise of the machinery destroyed all quietness during the daytime, and sleep was interfered with at night. Such an annoyance, it was said, must obviously be a nuisance, and injurious to health, and they asked the magistrate in the name of the inhabitants of the neighbourhood, some of whom had been in the occupation of their houses for upwards of 20 years, to grant them a summons against the company. Mr. De Rutzen reminded the deputation that a similar application had been made to his colleague, Mr. Cooke. The deputation said that they were aware of that, and that difficulties of a technical kind had arisen, but they were prepared to ask for a summons. Mr. De Rutzen remarked that some time ago he was asked to join with others to put down a similar cause of complaint in a street near Piccadilly, where there was the strongest possible evidence of the existence of a nuisance. Counsel's opinion was taken, and as a result an injunction in Chancery was applied for and granted. The deputation replied that they were anxious for process in this court, as it was most important that as much time as possible should be saved, and besides there was the question of expense. Mr. De Rutzen said that if a summons were granted for a nuisance it would be necessary to call scientific evidence to show that it was injurious to health. The deputation informed the magistrate that the machinery in use was said to be more powerful than that used at the Inventions Exhibition. Mr. De Rutzen said that if the deputation would draw up an information, setting forth the facts on which they relied, he would communicate with Mr. Cooke, who had already been consulted in the matter, and let them know the result. Replying to the magistrate, the deputation said that the company had been communicated with, and although an abatement of the nuisance had been promised, there had not been any sensible lessening of the cause of annoyance.

The Electric Light at Hastings.—At the last monthly meeting of the Hastings Town Council, a committee recommended that the existing contract with the Electric Light Company, for the lighting of the front, from the Queen's Hotel to Warrior Square, by means of fifteen 2,000 nominal candle-power arc lamps, for the sum of £450 per annum, which expires on the 26th inst., be renewed for another year.—Mr. Alderman Davis, who moved the adoption of the report, was disappointed at not being able to move a report embodying a more extended use of the light. It was very well known that the Electric Light Company had been in considerable difficulties during the last year or two, and had not yet felt themselves able to go in for a more extensive application of the light to the town. He hoped in another year to find that the company were in a position to extend the operation of the light, not necessarily along the parades, east and west, but in the inland parts of the borough. They really could not now do without their beautiful light on the front.—Mr. Duke seconded with a great deal of pleasure. The expense was a great deal, it was true, but it was patent to everyone that the light was a most essential and admirable arrangement. It was a great pity that at present the committee were unable to extend the area of lighting; but whilst they could have the light along the front, he thought they should endeavour to continue the expense of it. They must keep pace with other towns in this matter.—Mr. Revill said the electric light was a great advantage, and the whole town certainly reaped the benefit of the visitors who came down here, and whom the light so pleased. He should like to see the lighting extended all over the town, and some arrangement entered into with the Gas Company to light the gas lamps when the electric lights were put out. It was done at Eastbourne, and why should it not be done here? He believed the directors would be willing to entertain any reasonable suggestions in this way. He understood that by the new year the Council would be prepared to carry out their arrangements on an altogether different footing than hitherto. If they went back to the old state of things they would not be keeping up with the times as they ought. Mr. Alderman Davis would like to explain that, even if they did have the gas turned off on the front whilst the electric light was burning, the saving would be very small. They only burnt about 1,000 feet a night, and that was but 3s. 8d. He should be very sorry to see it abandoned now, as they were getting into a sort of permanent arrangement with the company. He hoped before long to see a permanent and efficient system of lighting on a more extended basis. The report was then adopted, without opposition.

Telephonic Communication between Devonport Dockyard and the Admiralty.—We understand that it has been decided to establish a telephonic line of communication between Devonport Dockyard and the Admiralty Offices at Whitehall. Hitherto, as in the case of the other Dockyards, a private telegraph wire has been utilised for the purpose of transmitting important messages from Devonport to headquarters. The proposed mode of communication will, however, be far more convenient, especially in times of high pressure. The work, which will be one of considerable magnitude, is to be carried out by the Post Office authorities, who, in case they succeed, will, no doubt, have similar work to carry out in connection with the other Dockyards.

Telephone Currents.—Last week we published an interesting paper on the Thermal Telephone, from the pen of Professor Cross, and in our present issue we are again, through that gentleman's courtesy, enabled to present to our readers another communication on a kindred subject.

The Telephone in Dundee.—According to the latest list of subscribers to the National Telephone Company's Dundee Exchange, there are 95 more telephones in use in the town than when the May list was issued.

The Telephone at Northampton.—The number of subscribers at the exchange recently opened at Northampton by the South of England Telephone Company has doubled within the last two months, and the officials anticipate speedy additions to the forty names already obtained. It is proposed to join up Wellingboro', Kettering, and Rushden, which will still further increase the utility of the system.

The Telephone in Aberdeen.—The October list of the National Telephone Company for its Scottish North Eastern district, shows that an increase of just fifty subscribers has been obtained during the present year, the number of exchange connections being 455. There are 510 of the Company's instruments in operation in the district.

The Manufacture of Telephones.—We learn that Mr. Todd, the Postmaster-General of South Australia, and Mr. Cracknell, superintendent of telegraphs for New South Wales, last week visited the factory of the Consolidated Telephone Construction and Maintenance Company. The machinery lately introduced from America attracted considerable attention, as did the process of making magnets. The switch boards of the consolidated pattern got their full meed of praise; and the latest improvement, the new magneto bell, with tooth wheel gear and patent cut out, met with the highest approval. The consolidated transmitter was also examined; the company claims that this instrument is the best transmitter of the human voice at present known. We understand that a further visit is contemplated.

American Telephone Patents.—A New York contemporary says:—Three several petitions have been presented to the Department of Justice asking that suits in equity be brought to vacate the Bell patents now owned by the American Bell Telephone Company. Two of these petitions were presented by the Globe Telephone Company, and the other by the Washington Telephone Company. The Department of Justice has referred the petitions, with the accompanying papers, to the Department of the Interior, for the "report, advice, and recommendation of the Secretary of the the Interior." The Secretary of the Interior, in turn, has referred each to the Commissioner of Patents for his "report and opinion." Mr. Montgomery, the commissioner, has not yet reported to the Secretary of the Interior, but has submitted to him a brief summary of each case. Secretary Lamar directs and will order that, inasmuch as his "advice, opinion, and recommendation" are invited, he will ask all the interested parties to appear before him and the Commissioner of Patents, to exhibit all facts, and answer the following questions:—First, Has the Government the right to institute and maintain such a suit for such a purpose? and, Second, If it has, do the facts as they shall be presented warrant or demand that such suit be brought? All proceedings will be held publicly. It is reported in telephone circles that Commissioner Montgomery, in his report as to these several applications, will not undertake to go into the general question of the scientific character of the new inventions, but will confine himself to a report of the facts as he finds them in the records of the Patent Office.

Long Distance Telephony.—The New England Telephone and Telegraph Company has just completed a new line from Boston to Worcester, Mass. It is built of No. 12 B. and S. gauge hard drawn copper wire, and conversation is now carried on daily between the two points named, and also between Boston and Springfield, as easily as to any suburban point. The distance between Boston and Worcester is 45 miles, and Boston and Springfield 100 miles. The same company has just completed a copper wire of the above description between Boston and Portland, Me.—a distance 116 miles—which makes it possible to talk with Lewiston, Me., and conversation is easily carried on with these places, using the ordinary Blake transmitter.

The Improved Telegraphic Facilities at Portsmouth.—The action of the Postmaster-General in conceding to Portsmouth all night communication is highly appreciated, although perhaps the increase of business consequent thereon has not been particularly large. The headquarters of the Telegraph Department are now centred in the large and commodious Post Office which has been built in Commercial Road, opposite to the principal railway station. The arrangements for the telegraph clerks are of a satisfactory character, their large apartment being well lighted, well ventilated, and in every respect convenient. A number of new clerks and learners have been engaged consequent on the accession of business through the introduction of sixpenny telegrams, with the result that the general arrangements are now of a character worthy of so large and important a town.

Telegraph Instruments Wanted.—The Midland Railway Company is advertising for tenders for the supply of telegraph instruments, wire, &c., to be sent to the Secretary of the General Stores Committee, Derby, not later than nine a.m. on Wednesday, the 18th inst.

Telegraph Revenue.—The receipts on the telegraph service from April 1st to November 7th, 1885, amounted to £1,080,000; a similar sum was also received from April 1st to November 8th, 1884.

The Spanish Cables.—The Direct Spanish Telegraph Company intimates that its direct cable communication with Spain, *viâ* Bilbao, is now restored.

The ss. "Dacia."—Letters have been received from Suez descriptive of the severe gale encountered by the *Dacia* in the Bay of Biscay from the 8th till the 10th of October on her voyage out to the Persian Gulf. She sailed from the Thames on the 6th, followed two days later by the *International*, and besides her officers and crew had on board the chief of the expedition, Colonel Bateman-Champain, R.E., director-in-chief of the Indo-European Telegraph. There were also on board the *Dacia* Sir Henry Mance, C.I.E., electrician of the Persian Gulf cables; Dr. Denis Scully, of the Persian Telegraph staff; and a few passengers accompanying the expedition, among whom were Colonel G. A. Leach, R.E., Land Commissioner of England. The *Times* gives extracts from a private letter from Colonel Bateman-Champain to a friend in England, giving particulars of the storm and of a slight collision which afterwards occurred at Port Said.

Experiments in Submarine Mining.—During the past week some important experiments in submarine mining were carried out in the torpedo field opposite the sea fronts of Forts Monckton and Gillicker, near Portsmouth, by Captain Markham and Commander Robinson, of H.M. torpedo ship *Vernon*, and Major Bucknill and Captain Wrotesley, of the Royal Engineers. A heavy mine, consisting of 500 lbs. of gun cotton enclosed in wrought iron cylinders, was sunk at each corner of a quadrilateral, all four being in separate electrical communication with a battery in Fort Gillicker. Both within and without the lines, at various known distances from these mines, were submerged a large number of cases of various construction and shape, loaded with dummy gun cotton, as target mines; the object of the experiment was to ascertain the effect upon the different structures of the explosion of heavily-charged submarine mines in the neighbourhood. It is believed that one of the target mines was broken up, but a careful examination will have to be made before the actual result can be definitely ascertained.

Harrison, Cox-Walker & Co.—We are informed that this partnership has been dissolved by mutual consent, and that the business will in future be carried on by Mr. E. Cox-Walker, under the style of Cox-Walker and Company.

"The Mill by a Turning of the Brook."—The capital lines which we give below are to be found in the current number of the *Monthly Correspondent*:—

"I whirr and whirl with flashing turn
Without a pause or rally;—
At least I ought such games to spurn
Electro-statically.

"Incessantly I hurtle round
Like a whole tribe of midges,
I balance paper, ink and sound
Like one of Wheatstone's Bridges.

"So into every arm I throw
My twirliest endeavour,
For slip may run and ink may flow,
But I drone on for ever.

"The Station-Diary displays,
And chronicles my revels,
And gives the number of my trays—
Those active little devils!

"And weary ears at night I fret,
Complexions growing yellow
Beneath the lamplight flickering yet
Around each sleepy fellow.

"I rattle, rattle, for I know
Discord and I can't sever,
And traffic come or traffic go,
Yet I drone on for ever.

"When rain is lashing like a knout,
And streets require baling,
The ink, instead of spurting out,
Will often take to failing;

"And mortals rub my panes and shake
The rod to make it travel,
And take and bake, and nearly break,
The mischief to unravel.

"Till rod fixed low, and panes aglow,
The ink runs like a river,
For sun may come, and storm may blow,
But I roll on for ever.

"The C. in C. around me trots
When he a fault discovers,
And o'er the grim Minotto pots
With water jug he hovers.

"Then gloomy-eyed with side-long prance
My wiry maze he follows,
And when the mischief meets his glance
Exultantly he holloas.

"He goes into particulars,
My framework he caresses;—
The Prob, that bans my natal stars,
His ignorance confesses.

"And once again *in statu quo*
I whirl and whirr and quiver,
For slip may run, and ink may flow,
But I drone on for ever!"

Underground Wires in Chicago.—There are now, according to American contemporaries, lying underground in the streets of Chicago some 2,125 miles of wire. There are 400 miles of wire belonging to the Bankers and Merchants' Company, 250 miles to the Postal Telegraph Company, 100 to the Baltimore and Ohio, 200 miles to the Western Union, 700 to the Chicago Telephone Company, 125 miles to the various electric light companies, 100 miles to the Chicago fire department, and 150 miles to ths Cook County Sectional Underground Company. There is a good deal more wire being laid every day. The way of connecting is by individual wires, so that the length of the underground wires lying beneath Chicago pavements is 2,125 miles. The bulk of this is to be found in that small section of the business part of the city extending in a radius of 200 yards around the New Board of Trade building. The wires lie thickest along Washington and La Salle streets leading to the Board of Trade. There are seven different systems lying in the ground there side by side, making a total of 150 wires running alongside each other in spots. The Chicago Telephone Company has extending from its building on Cbicago Avenue and Clark Street to the La Salle Stree -mnel some 400 wires.

Removal.—We have received intimation that Messrs. Heap and Stuart, electrical engineers and contractors, have removed from 62, Coleman Street, to 19, Ludgate Hill, E.C.

The Royal Society.—The following is the list of names recommended by the President and Council of the Royal Society for election into the Council for the year 1886, at the forthcoming anniversary meeting on the 30th inst. :—President, Prof. George Gabriel Stokes, M.A., D.C.L., LL.D. Treasurer, John Evans, D.C.L., LL.D. Secretaries, Prof. Michael Foster, M.A., M.D., Lord Rayleigh, D.C.L. Foreign Secretary, Prof. Alexander William Williamson, LL.D. Other members of the Council, Prof. Robert B. Clifton, M.A.; Prof. James Dewar; Prof. William Henry Flower, LL.D.; Archibald Geikie, LL.D.; Sir Joseph D. Hooker, K.C.S.I.; Prof. Thomas Henry Huxley, LL.D.; Admiral Sir A. Cooper Key, G.C.B.; J. Norman Lockyer, F.R.A.S.; Prof. Henry N. Moseley, M.A., F.L.S.; Prof. Bartholomew Price, M.A.; Professor Pritchard, F.R.A.S.; William James Russell, Ph.D.; Prof. J. S. Burdon Sanderson, LL.D., Prof. Arthur Schuster, Ph.D.; Lieutenant-General R. Strachey, R.E., C.S.I.; General James Thomas Walker, C.B.

Removal of Offices.—Messrs. Paterson and Cooper intimate that on and after the 16th inst. their offices and show rooms will be removed from Little Britain to their works at Pownall Road, Dalston, which are close to Haggerston Station, ten minutes from Broad Street.

Telegraph Men Injured.—Last week, at the Canal Railway Station, Paisley, two Glasgow telegraph labourers, George Dalziel and William Young, were engaged in the erecting of a box to hold the telegraph wires at the Canal Street Bridge, when the foot-board of the first carriage of a train from Glasgow struck the ladders, and as the two men fell, they went against one of the carriages and then fell to the ground. Dalziel was cut on the head, face, and hand, and was also seriously bruised. Young got his left leg much bruised, and he was also injured on the face.

The Royal Scottish Society of Arts Awards.—At last meeting of the Royal Scottish Society of Arts, Edinburgh, special thanks were awarded to James Hewat, of Alexandria, for his communication on "Time signalling in Egypt;" a Keith medal value fifteen sovereigns to Johnston Stephan, Ravelston Cottage, Blackhall, for his papers on "Improvements in telephonic and telegraphic apparatus," and "On telephonic switch tables and improvements thereon;" the society's honorary silver medal to James Kean, electrician, Glasgow, for his paper "On an improved form of portable Wheatstone bridge, and on an improved form of vibrating electric bell;" and the society's honorary silver medal to Samuel Benjamin Wilkins, for his paper "On a burglar and fire alarm."

The Elieson Electric Motor.—The cells used in connection with Mr. Elieson's motor, to which we referred last week, are, we are informed, the manufacture of the Electrical Power Storage Company.

The Blackpool Electrical Tramcars.—In our last week's issue we drew attention, on the authority of an engineering contemporary, to the frequent stoppages to which the cars on the Blackpool Electrical Tramway have been continually subjected. We understand that the cause of these serious annoyances was traced to the motors employed to propel the vehicles, and that these have been replaced by Siemens dynamos, since which time no further difficulties of an electrical nature have been experienced. Mr. Holroyd Smith and his Company will not, we hope, feel discouraged by these hindrances to regular and satisfactory locomotion, for all new undertakings are more or less troublesome at the offset.

"Something Wrong Somewhere."—Respecting our last week's note under the above heading, we now learn that the drawing of Mr. Holroyd Smith's electrical tramcar, as recently printed in the *Graphic*, is fairly accurate; but that the mysterious looking objects seen beyond the motor are not (as stated in that worthy journal) accumulators, but resistance coils.

Erratum.—In our last week's note relative to Elieson's electric motor, for 35 ampère hours in the last line read 35 ampères.

Immisch's Electro-Motor.—A friend who has heard glowing accounts of the efficiency of this motor, specimens of which were shown in the Inventions Exhibition, wishes to know whether it is not driven at an excessive speed when giving back the greatest return for power used in driving. If, says our correspondent, this is correct, is it not necessary, for tram-car and similar purposes, to reduce this speed by complicated gearing, thereby introducing an element of loss, and would it not, therefore, be more satisfactory to use a motor giving, say, a somewhat smaller return, but running at a comparatively slow speed, so as to be used direct without the interposition of gearing? Perhaps some of our readers can give the information requested.

Photography and Electric Lighting.—The Direct Photo Engraving Company, of 85, Farringdon Street, London, has been using the arc light recently for photographing direct and engraving on stone and zinc, by their patent process. Messrs. Heap and Stuart, of 19, Ludgate Hill, E.C., have put up the plant, consisting of a "Gramme" dynamo and "Clark-Bowman" arc lamps, driven from an "Otto" gas-engine.

Obituary.—We regret to record the demise of Dr. W. B. Carpenter, one of the foremost of English men of science, which occurred at his residence in Regents' Park Road, on Tuesday. Dr. Carpenter, who was in his 73rd year, recently received severe burns through the accidental overturning of the lamp of a vapour bath, and from those he died.

Persian Gulf Cables.—The cable steamer *International* arrived at Aden on the 5th inst. (all well), and proceeded to Jask (Persian Gulf) to meet her consort, the *Dacia*. This latter vessel arrived at Kurrachee (all well) with Col. Champain, R.E., and Sir Henry Mance on board, on the 10th inst., and proceeded immediately to Jask, where she expects to find the *International* awaiting her arrival.

Electric Head Lights in Russia.—Some time ago electric lamps were fitted to the locomotives running on the Nicholas Railway, between St. Petersburg and Moscow. For a while they appeared to give satisfaction, but at length the staff commenced to complain of them, and now, after an investigation by the directors, they have been totally discontinued. The lamps were powerful, throwing a stream of light a mile ahead of the train, and so far as the illumination of the railway track was concerned, the locomotive drivers and guards admitted their utility. Their objection to them was, however, that the contrast between the lighted space and the darkness on either side was so acute that it annoyed the eyesight, and in some cases, after a time, incapacitated the drivers altogether. Medical evidence was adduced by the company's doctors, proving that in one or two instances the vision had been so injured as to provoke fears of blindness. Although the electric lamps have been removed from the locomotives, the directors have not abandoned their intention of illuminating the line more liberally than is commonly the case. Two schemes have already been mooted, one for lighting the railway track for a distance of a mile each side of the station by means of suspended electric lights, and another for lighting the railway in a similar manner throughout its extent from Moscow and St. Petersburg. As very few accidents occur on the railway, owing to the slowness and the limited character of the traffic, it is not obvious that the gain would, in the latter case, be commensurate with the expense, especially as the decadence of Nihilism renders extra precautions unnecessary.

Electrical Formulæ.—We trust that those of our readers who are engaged in the construction of electrical apparatus may derive some useful hints from the paper by Mr. F. V. Andersen, which is concluded in this number of the REVIEW.

The Telegraph in India.—The question of dealing with Burmah and its king having come into prominence, the *Times* gives the following information respecting the Indian telegraph service:—"The telegraph line is constructed to the Kala Abdullah, and is working. During Sir Donald Stewart's late stay there, sufficient material was stored at Quetta to carry the line to Herat if necessary. This department is well directed and efficient, keeping abreast of possible requirements in India. Fifty per cent. of new stations were opened last year. When military preparations were lately undertaken with suddenly awakened energy, the Government omitted at first to give any directions to the telegraph department. Urgent orders were at length issued and were met with the satisfactory reply that already the material was collected and arrangements were made. The officers of the department have reasonable cause for complaint, and the Government should take into serious consideration the claims of a body by whom they are so well served."

The Signal Station on Tory Island.—At the monthly meeting of the Glasgow Chamber of Commerce on Monday, Mr. Hill, secretary, read several communications, in addition to the reply already received and published from Lloyds', regarding the proposal to establish a signalling and telegraph station on Tory Island, off the north coast of Ireland. The Admiralty reply that as such a station would only be on the rarest occasions of service to Her Majesty's vessels, they did not feel it incumbent upon them to do anything in the matter. The Irish Lights also look upon the matter as one which they would not be justified in carrying out, and the Trinity House forwards a somewhat similar reply. The Postmaster-General replies that in the event of a station being established, he would grant, at a nominal rate, the licence to communicate with the mainland.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES

Parker's Electric Wire Corporation, Limited.—An agreement, dated 23rd September, regulates the purchase by this company of the letters patent, No. 4781, of 1883, granted to Mr. J. G. Parker, for improvements in conductors of electricity. The purchase consideration is the allotment to Mr. Parker of 3,750 shares, to Mr. Edwin Andrew 1,000 shares, to Mr. Edward Robert Robson, 1,000 shares, to Mr. John Saunders Green, 1,000 shares, and to Mr. Edward Easton and his nominee, Mr. E. Blandford Blenkinsop, in equal proportions—750 shares. The said shares are to be credited as fully paid up.

CITY NOTES, REPORTS, MEETINGS, &c.

Eastern Extension, Australasia and China Telegraph Company, Limited.

THE twenty-fourth ordinary general meeting of this company was held at the City Terminus Hotel, Cannon Street, on Tuesday, Mr. John Pender, M.P., presiding.

Mr. F. E. Hesse, the secretary, having read the notice convening the meeting,

The Chairman said they had in the report a very full account,

not only in words but in figures, of the company's proceedings during the last six months. However, he should, as usual, make some remarks upon the report, which was in their hands. The gross receipts for the half-year had amounted to £259,476, against £237,672 for the corresponding period of 1884, showing an increase of £21,084. The working expenses for the same period had amounted to £74,418, against £66,658 for the corresponding half-year of 1884, showing an increase of £7,760, which was more than accounted for by the loss in connection with that unfortunate ship the screw steamer *Magneta*. The vessel, as was stated in the last report, was fully insured, but the company, in accordance with its usual custom, underwrote half the value of the cable on board, and the loss on this, together with the payments to the relatives of the crew, and the expenses of the ship whilst fitting out and upon the voyage, amounted to nearly £10,000, as was shown in the report. This they had written off. The net revenue, therefore, for the half-year was £140,358, against for the corresponding period of 1884 £127,415, showing an increase of £12,943. The usual dividends at the rate of 5 per cent. together with a bonus of 2s. per share, making a total payment of 3½ per cent. had been paid for the last half-year, and the balance carried forward, after charging a further sum of £20,000 towards the cost of renewing the Singapore-Saigon and Penang-Rangoon cables, amounted to £32,858. With regard to these cables he had frequently drawn attention to them, and intimated that they were about to relay some portion of the line on account of the action of the teredo. It was anticipated that the whole operation would have been completed before June 30th, so that the cost would be shown in the accounts under review, but it was found inconvenient to pick up the whole of the old cable until the close of the half-year, and, consequently, the final figures would be given in the accounts for the current half-year. No fresh renewal had been carried out during the half-year, but the directors had decided to pick up the cable, 400 knots in length, laid in 1870, between Singapore and Penang, which had for some years past, and especially of late, been much interrupted, necessitating frequent and costly repairs, and to put down a new brass-ribboned cable in its place. This was a scheme which had frequently been referred to, but the cost really had been such that by laying down the new cable they expected to get rid of a very considerable annual outlay in repairs. The cable they took up was not lost; they reserved it and used it for other purposes; they put it into stock at Singapore, and when occasion arose they used it for purposes which generally brought them a fair return. For instance, last year, with the stock of cable which they had at their command they were enabled to meet the requirements of the Government, indirectly, through the Telegraph Construction Company, by laying a cable to Port Hamilton at a time when the Government considered it a very desirable work to do. Consequently, while it appeared that they were spending a considerable amount of money in relaying this cable, they had generally found that in the end there had been no real loss. He might mention that the Port Hamilton cable had been since broken, but they expected it would be in working order shortly. Since he last addressed them they had had a new steamer built to replace the one that was lost. They had never heard any account of the *Magneta*, and it was one of the most extraordinary things that had ever occurred to a vessel so well found in every way that it should have entirely and completely disappeared. They had named the new steamer the *Recorder*. The recorder instrument was the instrument invented by Sir William Thomson, the greatest electrician of the age, and probably, as an instrument, it was the nearest approach to human action that had yet been introduced in electric telegraphy. They thought it only a proper compliment to pay to the great electrician to name their ship after his most important and valuable instrument. That ship was now lying in the Thames, and, probably, a more complete ship had never been fitted out for the purpose. She would proceed shortly to Singapore, and, he hoped, would prove of valuable service to the company. But, as he had said before, the less she was employed the better for the company. These were the more particular points connected with the working of the company; but there was a question which, no doubt, many of them would be interested in, and he would tell them something of what occurred at the Berlin Conference. The submarine companies at those conferences had no vote—they were allowed to speak but not to vote—and they must through moral suasion, coming into contact with the delegates representing the different States, endeavour to influence them more or less, and impress them with the justice of their appeals to the conference; and if those appeals were not based on justice, they might be assured that they would not carry their point. President von Stephan, whose whole object was to get rates reduced as much as possible, recognised the value and importance of submarine cables, and he said that there was great necessity for the submarine cables, which had their origin in England, but gave to every other State in Europe the same advantages which England derived. In these days, when the European States were looking all round the world for colonies, they could well understand that they took a lively interest in submarine telegraphy, and they endeavoured, as far as their influence and power went, to make the companies reduce their rates as much as possible. They therefore, as a company, or as a combination of companies, had practically to fight the European Governments. It was the companies *versus* the Governments. But when he told them that the companies owned 98,450 miles of submarine cables, costing £34,460,000, whilst the Governments only owned 7,300 miles of cable costing £1,460,000; and when he told them that the value of their cables was more than the value of all the landlines belonging to the whole of the States of Europe, they would understand that their position was a very important one, and one which they had to defend with all the intelligence they could bring to bear. There was one very important point dealt with at the conference, and that was as to how far they could reduce their rates. The Eastern Extension Company had for some time been considering the necessity of reducing the rate to Australia. For why? They found a considerable amount of vitality in the Australian traffic, and they thought that by reduction they could perhaps increase, after a year or two, or it might be three years, the traffic so as to get back something like the amount they were now earning. They were anxious to make that reduction. They appreciated this state of vitality on the part of the Australian people in using their telegraphs. But they felt that India, which was a party to this scheme, and Australia should take part in the reduction. He announced that he was quite prepared on the part of the companies to make a reduction, provided India and South Australia reduced their proportions. Australia agreed at once to reduce its proportion. He might mention that they telegraphed to Australia at night, and so promptly was the matter attended to, that in ten hours they had the reply that Australia was prepared to reduce. India, on the other hand, replied that the exchequer could not afford it, and so declined. He was urged then very strongly to give up the portion to Australia; but he said no, he would not give up the portion to Australia now, because he had the Australian colonies as a lever to act upon the Indian government, and that he was not going to give up the opportunity which he had been working for for the last two years, to get them to make a concession; he was not going to give up the advantage he had got in having the influence and assistance of the Australian government and agents to bring pressure upon the Indian government. He would just give them an idea with regard to one portion of what he called the hardships which the Australian people had to submit to from the charges of the Indian government. If they had the same arrangements with the Indian government for the transmission of their messages across India for Australia that they had with the English government, that was, having a special wire, and paying so much for that wire, the difference would be that they would pay the Indian government £3,500 a year, whereas now they paid £40,000 a year. If they could get that reduction it would enable them to give the Australian colonies a reduction of two shillings per word, in addition to the two shillings they were prepared to give them in view of increasing the traffic, and this would give them such an advantage in the reduction of the rates as would eventually, he believed, lead to a very large increase of traffic. That was the position they held at the present moment. They were endeavouring to bring pressure to bear upon the Indian Government; they were being supported by the Australian Agents-general in the work which they had in view; and he was hopeful that before he again had the pleasure of addressing the shareholders, they would have carried their point in that direction, largely benefitting Australians, who were entitled to consideration, and at the same time, he thought, not very seriously injuring the returns of the company. He might mention that any change now contemplated was not likely to interfere in any way with the dividends of the company. The amount of reduction, if carried out, both to India and China, would not exceed £40,000 a year, and he believed that in the course of two years they would be able to recoup that. In the meantime they would receive their dividends, unless some unforeseen circumstance arose, very much as they had done previously. The Conference did not meet again for five years, and he hoped after that time they would be comparatively at rest. But he wished to say now publicly, that, always bearing in mind that they had to pay dividends, and that they ought rather to be moving upward than downward, they would endeavour as far as possible out of the growth, where they saw there was a decided growth in the traffic, to meet that by such reductions as they felt themselves warranted in making without injury to the best interests of the company and the shareholders. They had to pay dividends, and governments had not; and many of the telegraph systems in Europe did not pay, consequently they had to draw upon their exchequers. That the company could not do, and he thought the position they occupied now entitled them to consideration as giving a service, perhaps second to none, and with no possibility of competition arising—at least competition might arise, but none that could for a moment do the work cheaper or so well as they were doing it. He might just as well give them a further illustration of that. The Eastern Extension Company took its departure from Madras. Up to Madras messages were forwarded by the Eastern Telegraph Company, which gave such a rebate to the Eastern Extension Company as no other company could obtain, the consequence being that the Extension Company was in a very safe position through that rebate alone. He wished to mention one thing good humouredly before he concluded; at the same time, he thought they had rather to complain of a want of courtesy on the part of the Press. He spoke only of certain papers. For some years they could not get the German Government to make a reduction in Press rates. They had always, as a rule, given quarter rates to the Press. It was his wish, or the wish of the board, that they should continue that to Australia; but they were never able to get permission to carry the thing through. At the very first interview he had with the Postmaster-General of Germany, when he was proposing certain reductions, he (Mr. Pender) said: "Sir, for years you have stopped progress in telegraphy. You are now making a new departure; your desire is to reduce rates and increase the traffic. Now, the first thing I ask you to do, in the interests of the Press, is to reduce to

quarter rates." He could not get out of it, and he admitted it was right. Now, while they had been blamed for not making large concessions, he had never heard one compliment given to them for giving the Press this advantage. The Press were rather hitting them hard for not giving up 1s. 6d. because India would not give up 3d.; but they might have admitted that they themselves had an enormous advantage. They did not admit it, and he therefore thought they (the companies) had some reason to complain that they were not supported by those they did so much to benefit. He hoped the Press would take this good-humouredly, and if all their acts did not meet with approval, that they would have the courage at least to give them the help and commendation to which they were entitled. In conclusion, he begged to move the adoption of the report.

The Marquis of Tweeddale seconded the motion.

Mr. Newton asked for information as to the business with China. He did not think that China suffered so much from depression of trade—or at least they did not talk so much about it—as other countries. He would like to know if they had a prospect of improved trade in the Far East.

The Chairman said perhaps no country at the present time wanted money more than China did. But if the Chinese people gave contracts to European contractors—and they were moving in that direction—for the erection of railways through their country it would be an enormous benefit to the telegraph system.

The resolution was then put, and carried unanimously.

Mr. Heiron moved a vote of thanks to the chairman, which was seconded by Mr. Griffiths and carried, the meeting thereupon terminating.

"Pilsen-Joel" and General Electric Light Company, Limited.

THE report of the directors to be presented to the shareholders at the fourth ordinary general meeting, to be held on Thursday, the 19th day of November, 1885, says that—

"It will be satisfactory to the shareholders to learn that on the expiration of the tenancies of the Malden Factory and the City Offices at Midsummer last, the directors succeeded in procuring a factory and offices together at No. 15, Edward Street, Hampstead Road, at the low rent of £100 a year, on a yearly tenancy.

"The manufacturing plant, except a small quantity required at the new factory, and the stock not actually suitable for installations in hand or saleable to the company's customers, was disposed of by auction before quitting the Malden Factory. The remaining plant has been re-valued.

"The position of affairs at the close of the year to 30th June, 1885, is shown in the accompanying balance sheet, and it will be observed that a separate item is given for the outlay on patents and other expenditure which can no longer be considered as an asset. The goodwill and patent rights remain at cost price to the company.

"In consequence of the removal to the new premises, the directors have been able to reduce the company's staff to a minimum, and have arranged with Mr. Trentham to combine with his duties as engineer those of secretary and general manager of the company.

"The directors feel satisfied that in the new premises the profit rentals from installations, royalties from licenses, and other receipts, may be confidently expected to more than cover all the general charges of the company, including rent of factory, staff, directors and auditors' fees, &c., and they look to the increasing development of electric lighting as a means of improving the value of the capital invested in the company.

"The point may present itself to shareholders that a further amount should be written off the company's capital as lost, but although this subject has engaged the directors' attention they have not considered any advantage would accrue from taking the step at present.

"The retiring director is the chairman, Sir Rawson W. Rawson, who being eligible offers himself for re-election.

"The auditors to the company, Messrs. Broom, Hays & Akers, retire, but being eligible offer themselves for re-election."

The manufacturing account, and account of the realisation and re-valuation of the stock and plant, for the year ending 30th June, 1885, are as follow:—*Dr.*—To stock, plant, &c., on hand 1st July, 1884, as per balance sheet at that date, £25,932 7s. 7d.; to purchase of stock, stores, wages, and manufacturing expenses, £4,664 13s. 6d.; to working expenses of installations, £1,720 8s. To general expenses: Directors' fees, £337 15s. 6d.; auditors' fees, £36 15s.; head office salaries, £753 16s. 8d.; head office rent, £287 10s.; law charges, £404 10s. 10d.; patent fees, £131 6s.; insurance, £37 9s. 10d.; discount on sales, £94 16s. 4d.; commission and agency, £42 17s. 8d.; advertising, £91 3s.; travelling expenses, £22 6s. 8d.; miscellaneous expenses, £421 5s. 6d.; to apprentice fee returned, £50; to bad debts written off, and to further provision against bad and doubtful debts, allowances, &c., £619 1s. 6d.—total, £35,648 3s. 7d. *Cr.*—By sundry sales, lamps, dynamos and carbons, plant, stock, stores and sundries, £5,878 3s. 6d.; by sundry receipts: interest, £46 15s. 10d.; royalties, £30; sundries, £16 13s.; by rents, &c., from installations, £2,524 5s. 7d.; by profit on sale of installations, £66 16s. 9d.; by stock, plant, &c., on hand 30th June, 1885, on revaluation, £2,653 0s. 2d.; by balance carried down, £24,432 8s. 9d.—total, £35,648 3s. 7d.

The balance sheet to 30th June, 1885.—*Dr.*—Capital and liabilities: To capital account as reduced—28,000 shares of £4 each, as £2 5s. paid, less arrears of calls on shares (4,003 1s. 2d.), £58,996 18s. 10d.; 100 fully paid shares (not surrendered) £4 per share, £400; to sundry creditors, £341 1s.—total, £59,737 19s. 10d. *Cr.*—Assets: By cash at bankers, invested, factory cash, £2,718 14s.; by sundry debtors after provision for bad and doubtful debts, allowances, &c., £1,001 5s. 6d.; by stock, plant, stores, &c., on hand, as per preceding account, £2,653 0s. 2d.; by goodwill and patent rights, as per last balance sheet (£76,103 8s. 8d.), less value of 11,900 fully paid up shares surrendered (£59,500), and less payment for their surrender (£13,883 6s. 8d.), £30,486 15s. 4d.; by balance of outlay on patents, goodwill, and general working expenses, after deducting capital written off, as per last balance sheet (£57,032 11s. 5d.), less goodwill and patent rights, as above £30,486 15s. 4d.), (£26,545 16s. 1d.), to which add balance of manufacturing, &c., account (£24,432 8s. 9d.), and deduct £1 per share on 28,000 partly paid shares, and £1 per share on 130 fully paid shares, reduced and written off as per order of Court (£28,100), gives £22,878 4s. 10d.—total, £59,737 19s. 10d.

The West India and Panama Telegraph Company, Limited.

THE report of the directors for the six months ending June 30th, 1885, states that the amount to credit of revenue is £51,012 1s. 7d., and the expenses have been £28,038 11s. 8d., leaving a balance of £22,973 9s. 11d., which, with the balance of £500 2s. 10d., brought from last account, makes a total of £23,473 12s. 9d Of this sum the directors have placed £6,000 to reserve, leaving an available balance of £17,473 12s. 9d., with which it is proposed to deal as follows:—

	£	s.	d.
Payment of 9s. per share on account of arrears of dividend on the first preference shares ...	15,553	7	0
Balance to current half-year's account ...	1,920	5	9
	£17,473	12	9

The traffic receipts for the half-year show an increase of £2,459 1s. 2d. over those of the corresponding period of 1884, attributable to a lesser number of interruptions, and to the disturbances in Colon during the month of April last.

The ss. *Duchess of Marlborough*, which came home in July to be refitted and supplied with a new boiler, has been thoroughly overhauled in accordance with Lloyd's requirements, and has since returned to St. Thomas with 77 knots of new deep-sea cable, manufactured by W. T. Henley's Telegraph Works Company, Limited.

In order to proceed with the repairs of the original Jamaica-Santiago de Cuba section referred to in the last report, and to meet any other contingencies, a contract has been entered into with Siemens Brothers and Co., Limited, for the manufacture of 250 knots of deep-sea cable, and the company's ss. *Grappler* is on her way home for the purpose of carrying out this cable.

Several sections of the company's line were interrupted during the period under report, but they are now in good working order.

Western Union Telegraph Company, Limited.—The receipts for the year ended 30th June last were $17,706,834 and the expenses $12,005,910, the profits being $5,700,924, making, with $4,157,469 brought forward, a total of $9,858,393. Dividends, interest on bonds and sinking fund appropriations have absorbed $5,534,389, leaving as surplus on the 1st July last $4,324,004, being an increase of $166,535 to the amount brought forward. This represents the accumulated surplus since 1st October, 1881. The capital stock is $80,000,000, of which $20,969 belongs to us and is the treasury of the company. The total bonded indebtedness is $6,874,886.

Telephone Company of Ireland, Limited.—According to the report and accounts for the six months ended the 30th June last, the amount standing to credit of net revenue account, including the balance of £162, brought forward from last account, amounts to £1,546. After payment to the preference shareholders of the full dividend amounting to £747 (paid on the 14th July last), a dividend at the same rate as for last half year, namely, ¾ per cent. per annum, has been declared upon the ordinary shares, leaving £142 to be carried forward.

The Eastern and South African Telegraph Company, Limited.—This company states that on Monday, the 16th of November, at 2 p.m., at the offices, Winchester House, 50, Old Broad Street, 1,203 first mortgage debentures of £100 each will be drawn for payment on the 1st of January, 1886. Notice will be given by advertisement of the numbers of the debentures drawn.

TRAFFIC RECEIPTS.

The Great Northern Telegraph Company, Limited. The receipts for October, 1885, were £24,400; from 1st January to 30th October, 1885, £241,640; for the corresponding months of 1884, £234,680; and of 1883, £ 215,380.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending November 6th were £2,306, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The West Coast of America Telegraph Company, Limited. The gross earnings for the month ending October 31st were £3,475.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1884.

15143. "Improvements in boxes or cells for primary and secondary electric batteries." C. MOSELEY. Dated November 18. 6d. The inventor constructs these boxes of wood to any desired pattern or form and within each box he places a loose lining of India rubber moulded approximately to the internal form and dimensions of the box. The India rubber lining is by preference formed of soft vulcanite compound. Around the top outer edge of the box he forms a rebate into which the edge of the lining is turned and secured by fillets which may be nailed in position. Outside these fillets he plants or secures strips of wood which project above and surround the top of the box. The fillets are preferably of such a size that they do not completely fill the rebate so that there is left between the top of the box and the surrounding strips a shallow trough or groove. The space between the top inner edges of the box and the similar edges of the strips is then filled with paraffin wax or other analogous substance.

15155. "Improved electro-magnetic engine." S. W. MAQUAY. Dated November 18. 6d. The invention consists of lever arms like capstan bars of soft iron suitably made with heads so shaped that the greatest magnetic attraction, will be in a direct line with their axis, and said arms, fixed by screwing or springs or bolts, into a centre hub, which may be a casting of soft iron, this hub is insulated from the central shaft by hard wood or other insulator, the number of arms is regulated by the power required, and the space convenient in which they can revolve, each arm is wound with covered copper wire, in such a manner that each pair, situated in a direct line on each side of the hub, the head of one will be N and the head of the other will be S. Fixed electro magnets are placed near the line of rotation of the magnet poles.

CORRESPONDENCE.

A Hydro-Electric Meter.

Having devised an electric meter which embraces the hydrostatic principles, but differs somewhat in action to that of MM. Marchand and Gerboz (the interesting description of which you published in your issue of the 31st ult.), I enclose a rough sketch of same, thinking it would be interesting, and to show that MM. Marchand and Gerboz are not the only persons who have conceived the idea of using water or liquid in connection with eletric meters. The apparatus I am about to describe is capable of measuring 1 or 100 ampères; moreover, it is only necessary to place it in the main circuit; the arrangement of separate wires for each lamp would necessitate a considerable amount of wire running in large installations. Fig. 1 will explain the working parts; fig. 2 the external appearance. A^1, A^2 are small tanks containing water or other liquid; B, connecting pipe, the end of which forms a small pump; D; E, E, valves; F, electro-magnet of high resistance in main or shunt; this magnetic device is governed by the rise and fall of ball, G, in upper tank; H^1, H^2, tubes containing mercury; I, ball or cone in the larger tube; this ball or cone is actuated by the current which, by attracting the cone of solenoid, J, causes it to rise and displace a portion of the mercury in the smaller tube; this displacement uncovers the orifice or outlet of the supply tube, K, thus liberating a portion of the liquid which drops on or into the wheel, L, causing it to rotate in proportion to the flow. The working parts of the solenoid being balanced by means of an adjustable weight and the friction being reduced to a minimum, it is obvious that the apparatus will be very sensitive. The shape of the ball or displacement core or the shape of the orifice, or both, is such as to maintain the necessary flow of liquid in relation to the action of the solenoid. The actions of the meter are as follows: if no current is going out the meter is not in action, as the mercury in tube H^1 covers the orifice or outlet; if we turn on one ampère the cone or ball, I, is lifted by the core of solenoid being attracted, this action causes a displacement of the mercury in tube H^1 and uncovers a portion of the orifice or outlet, and a small quantity of liquid is conveyed by the tube, K, on or into the wheel, L; this wheel is connected with the index; if we use a greater quantity a greater displacement takes place, and a flow of liquid and consequent rotation of the wheel; the ball arrangement governs the level of water in the upper tank and also actuates the magnetic

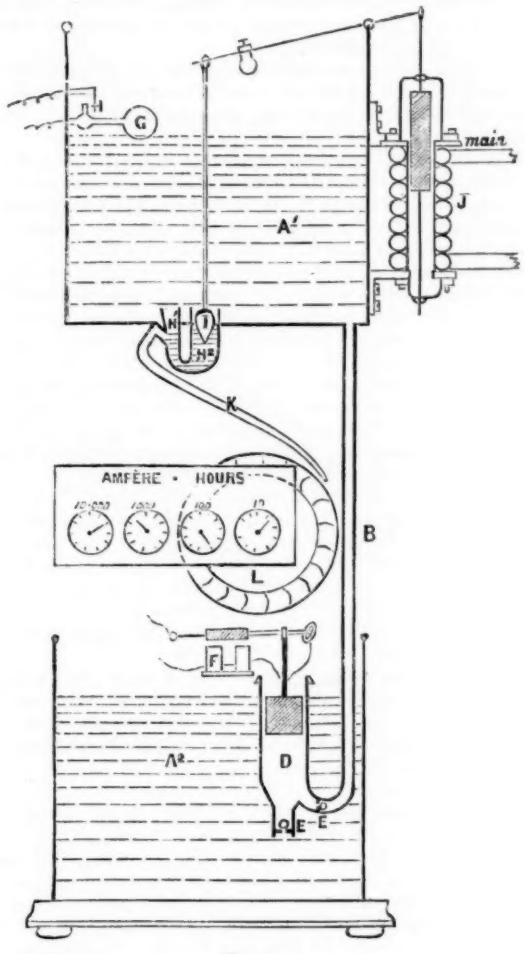


FIG. 1.

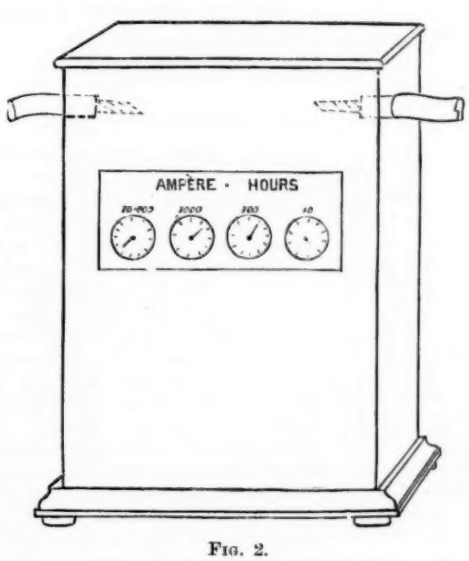


FIG. 2.

pump. The displacement and replacement of liquid is comparatively small; one revolution of the wheel per hour would equal one ampère hour, or more if desired.

Henry A. Kent.

154, Culford Road, N.

The Recent Sale of the Hammond Company's Effects.

Your remarks in your issues of the 24th and 31st ult., relating to the "results" and prices obtained, at the above important sale, are so wide of the mark, that we venture in justice to the vendors, ourselves, and the numerous purchasers, to ask you to insert a few words from us in explanation.

We will pass your facetious reporter's joke, "Was it writ sarkastic?" with the remark that the condition he italicised, was a special one, relating only to the Brush concessions.

We presume your reporter can only have called at the close of the first day's sale, and taken his cue from it. It is without doubt, a fact, that all the Ferranti dynamos sold at very low prices, and the reason for this is perfectly known to everyone in the trade; but in his apparent anxiety to show how other dynamos followed in like manner, your reporter has gone a little too far, the fact being that, the "Gramme dynamos, suitable for exciting the Ferranti machines," which "one buyer at the sale" is "now offering for £22 10s.," are *new machines* to be supplied by the firm in question, because the second-hand dynamos of similar capacity and unknown condition, actually realised more than the sum, for which this and half a dozen other respectable firms will make new ones!

Considering the great number of "Brush" 16 light machines that were included in the sale; the reduced prices and discounts now prevailing; the prices at which other good dynamos can be purchased, and above all, the unknown condition of those sold, it certainly speaks volumes for the estimation in which "The Brush" is held, when at this forced sale they averaged over £100 each.

The manufacturing plant realised very high prices; in fact, we, ourselves, had instructions from several large firms to buy most of it, without limitation of price, but we only secured one or two machines, our judgment not permitting us to go to the famine prices which prevailed.

With the exception of the Ferranti machines, the prices realised throughout were very high, and, indeed, if we could guarantee similar results, we could have electric plants more valuable even than this was, placed with us for sale at once.

Readers of your valuable paper who attended the sale would scarcely be tempted to come long distances to our future sales, if The Hammond sale prices indeed "ruled low."

Wheatley Kirk, Price & Goulty.

London, *November 9th*, 1885.

"Primary" and "Secondary" Batteries.

Can any of your readers define what constitutes a primary and what a secondary battery? At first sight this may not appear difficult, it being generally accepted that a secondary battery is one in which the elements, after being discharged, are brought into an active condition, in *situ*, by the action of a current of electricity. The question arises, however (and is important in view of some patents which have recently been taken out), does the claim of a battery to belong to the secondary class depend on the resuscitating process being an electrolytic one, whether in *situ* or not; or is it fatal to this claim if the elements are removed from the discharging cell in order to re-energise them? This question is the more important in view of the probable use, at no distant date, of lead in a spongey or active condition in the place of zinc; and possibly also of peroxide of lead as the depolarising agent in primary batteries. Mr. Fitz-Gerald has, I believe, already called attention to the advantageous employment of lead in the place of zinc, and I will on a future occasion, with your permission, say something on this subject in connection with some experiments on which I am now engaged.

In your issue of the 31st ult., you publish a letter from Mr. Fitz-Gerald, in which he claims that his new battery "is undoubtedly a secondary battery, since it can be discharged and recharged without any manipulation of the elements." The same may be said, however, for many of the well-known types of primary batteries. It may not be advantageous in most cases to adopt this method, but it can hardly be considered satisfactory that the distinction should rest on the mere question of convenience.

In connection with Mr. Fitz-Gerald's battery, I have hitherto understood that it was claimed to be essentially a primary battery, and since this claim is now abandoned, I trust the inventor will be able to give us the definition I have asked for at the commencement of this letter.

W. Kingsland.

Electric Light Carbons.

Will you allow me through the medium of your columns to take exception to one or two remarks in your article on "Electric Lighting in the United States," of the 31st ult.

Firstly.—That between disagreeable blue rays, and usual hissing noise and flickering, there is no happy medium.

This is not the case, as any good adjustable lamp can be so adjusted as to meet the circumstances under which it is being used, and entirely obviate both of the above faults.

Secondly.—That no experimenting appears to have been done in order to ascertain which is the most suitable current to use with a given diameter of carbon, and what is the proper length of arc to work with in order to give the best results.

The fact that the positive carbon ought to have a well defined crater appears to have been overlooked.

Careful experiments have been made, deciding the relations between a carbon and the current suited for it, and the centring of the crater is a subject that has received much attention.

Thirdly.—Copper-coated carbons have a good deal to do with unsteadiness of lights, and that a copper-coated carbon burns faster than an uncoppered.

Both these assertions are fallacies, and the last one being coloured, apparently, by the result of some carbon company's tests, is just the step from the sublime to the ridiculous, which any observant person, whose object is to purchase and not sell carbons, will easily see.

It requires but a very slight knowledge of science for anyone to perceive how the consumption of a carbon is retarded by its gradually-incandescing parts being preserved as long as possible from contact with the atmosphere.

Apologising for intruding on your space,

George Aunesley Grindle.

A Warning.

Will you allow me through your columns to call the attention of men engaged in electric lighting, more particularly engine drivers, to an impostor who is representing himself as the manager of the South Eastern Railway Company's Lighting at Cannon Street Station, and that he is authorised to engage a driver? He wears a cap with letters E.L.C. on the front, and has been successful in defrauding a number of men of various sums of money, amounting in one case to £2, under the pretext of providing them with uniform before they take charge. Several men have presented themselves prepared to take duty at once; others, more cautious, have come to make enquiries before resigning their situations. I hope with your assistance to prevent others from being swindled.

W. Leonard.

South Eastern Railway Telegraph Department,
Superintendent's Office.

Tunbridge, *November 5th*, 1885.